Environment CANADA Environnement
1020926I VOL ISS 70 850900
EXC # 001
TD 171.5.C3 R46
REPORT EE

OOFF

A STUDY OF FREQUENTLY-SPILLED MIXTURES

EE-70

A STUDY OF FREQUENTLY-SPILLED MIXTURES

by

P.T. Chung
S.L. Ross Environmental Research Limited
346 Frank Street
Ottawa, Ontario

This report has not undergone detailed technical review by the Environmental Protection Service and the content does not necessarily reflect the views and policies of Environment Canada. Mention of trade names or commercial products does not constitute endorsement for use.

This unedited version is undergoing a limited distribution to transfer the information to people working in related studies. This distribution is not intended to signify publication and, if the report is referenced, the author should cite it as an unpublished report of the Branch indicated below.

Any comments concerning its content should be directed to:

Environmental Emergencies Technology Division
Technical Services Branch
Environmental Protection Programs Directorate
Environmental Protection Service
Environment Canada
Ottawa, Ontario
K1A 1C8

EE-70

September, 1985

A STUDY OF FREQUENTLY-SPILLED MIXTURES

a report to

Environmental Emergencies Technology Division
Environment Canada

by

P.T. Chung
S.L. Ross Environmental Research Limited
346 Frank Street
Ottawa, Ontario

December 1984

TABLE OF CONTENTS

		Page
LIST OF TABLES		
1.0	Introduction	1
2.0	Pulp and Paper Liquors	2
2.1	General Description	2
2.2	Chemical and Physical Properties	2
2.3	Toxicity	4
3.0	Lead Concentrate	9
3.1	General Description	9
3.2	Chemical and Physical Properties	9
3.3	Environmental Behaviour	10
4.0	Zinc Concentrate	19
4.1	General Description	19
4.2	Chemical and Physical Properties	19
4.3	Environmental Behaviour	19
4.4	Environmental Toxicity	22
5.0	Drilling Mud	28
5.1	General Description	28
5.2	Chemical and Physical Properties	30
5.3	Environmental Toxicity	30
6.0	Latex Rubber	44
6.1	General Description	44
6.2	Chemical and Physical Properties	46
6.3	Environmental Behaviour	48
7.0	Latex Paint	51
7.1	General Description	51
7.2	Chemical and Physical Properties	51
7.3	Environmental Behaviour	52
8.0	Phossy Water	56
8.1	General Description	56
8.2	Chemical and Physical Properties	56
8.3	Behaviour in Water	56
8.4	Environmental Toxicity	57
9.0	References	59
APPENDIX A	Product Name, Description, Functions, Systems Used In and Distributors of Drilling Mud Additives	A1

LIST OF TABLES

Table		Page
2.1	Available Data for Pulp and Paper Liquors	5
3.1	Available Data for Lead Concentrate	13
3.2	Concentration of Lead and Zinc in Leaching Solutions	18
4.1	Available Data for Zinc Concentrate	24
4.2	Concentration of Zinc and Lead in Leaching Solutions	27
5.1	Available Data for Drilling Mud	37
6.1	Available Data for Latex Rubber	49
7.1	Available Data for Latex Paints	53
8.1	Available Data for Phossy Water	58

1.0 INTRODUCTION

Over the last ten years, a large number of spills in the Canadian environment involved mixtures of chemicals. This report is a first attempt to collect physical and chemical, environmental behaviour and environmental toxicity data for the following mixtures: pulp and paper liquors, lead and zinc concentrates, latex rubber and paint, and phossy water.

2.0 PULP AND PAPER LIQUORS

2.1 General Description

White, black and green liquors are used at various stages of the Kraft (sulphate) papermaking process. White liquor is used in the "cooking" stage of the Kraft process. The purpose of the white liquor is to loosen and separate individual wood fibre cells. The spent white liquor containing the dissolved organic materials is called the black liquor. The black liquor is generally regenerated back to the white liquor, and green liquor is the intermediate during this regeneration stage (Kirk-Othmer 1980, Bruley 1974).

2.2 Chemical and Physical Properties

2.2.1 White Liquor

The composition of white liquor varies considerably depending on the process requirements and the type of wood being processed. Major components of white liquor are sodium sulphide and sodium hydroxide. Approximate composition of the major components of a typical white liquor is shown in Table 2.1. The density is approximately 1.1 g/mL, and the pH range of the liquor is 13 to 14 (MacDonald 1969, Kirk-Othmer 1978).

2.2.2 Black Liquor

The composition of the black liquor depends on the pulping process and the wood species used. The major components of black liquor and elemental analysis of a typical black liquor is shown in Table 2.1. In addition, the following compounds are identified in black liquors: hydrogen sulphide, sodium hydroxide, sodium sulphate, sodium carbonate, sodium thiosulphate, sodium hydrosulphide, methyl mercaptan, and dimethyl disulphide (Kirk-Othmer 1978, Marier 1973, Bruley 1974, Beckwith 1981). The specific gravity and viscosity of a typical black liquor at different temperatures and various solid contents are shown in Table 2.1. Generally, black liquor has a solid content of 50 to 70 percent by weight (Kirk-Othmer 1978), and a pH of 10.6 to 11.0 (Dhaneshwar 1970).

2.2.3 Green Liquor

The following compounds are identified in a typical green liquor: sodium sulphide, sodium carbonate, sodium sulphite, sodium sulphate, calcium carbonate, magnesium aluminum silicate, and manganese dioxide (Kirk-Othmer 1978).

2.3 Toxicity

Weak black liquor has been found to exhibit toxic and mutagenic activities and has caused damage to the chromosomes of growing Chinese hamster ovary cells (Lee 1981).

Table 2.1 Available Data for Pulp and Paper Liquors

GENERAL

Composition (wt %):

1) Approximate Composition of White Liquor:

Chemical	Formula	Concentration
		(g/L)
Sodium hydroxide	NaOH	100 to 120
Sodium sulphide	Na2S	20 to 40
Sodium carbonate	Na2CO3	20 to 30
Sodium sulphate	Na2SO4	10 to 20
Sodium sulphite	Na2SO3	small
Sodium thiosulphate	Na2S2O3	small
Sodium chloride	NaCl	small

(Kirk-Othmer 1978)

Table 2.1 Available Data for Pulp and Paper Liquors
(Continued)

2) Major Compositions of a Typical Black Liquor:

Component	Composition
	(%)
Lignin	36 to 47
Organic acids	35 to 39
Organic extractables	5 to 6
Inorganics	9 to 23

(Sjostrom 1981, Sjostrom 1983)

3) Elemental Analysis of Typical Black Liquor:

Element	Composition
	(%)
Carbon	42.6 to 48.6
Oxygen	25.9 to 31.7
Sodium	17.5 to 18.3
Hydrogen	3.6 to 6.1
Sulphur	1.8 to 3.6
Inert Mineral Oxides	about 0.2
Nitrogen	about 0.1

(Beckwith 1981)

Table 2.1 Available Data for Pulp and Paper Liquors (Continued)

PHYSICAL AND CHEMICAL PROPERTIES

Density:

Specific Gravity of Typical Black Liquor

Solids Content	Specific Gravity			
	15.6°C	37.8°C	60°C	93.3°C
(%)				
10	1.05	1.04	1.03	1.02
30	1.16	1.15	1.14	1.12
50	1.32	1.30	1.28	1.25

(MacDonald 1969)

Table 2.1 Available Data for Pulp and Paper Liquors
(Continued)

Viscosity (mPa.s):

Viscosity of Typical Black Liquor:

Solid Content (%)	Viscosity (mPa.s) 30°C	70°C	105°C
1) Softwood Black Liquor			
17.3	2.2	1.17	--
33.5	6.5	3.4	--
47.3	52	11.5	5.5
61.7	253	31.5	10.5
2) Hardwood Black Liquor			
15.3	1.75	--	--
41.7	50	70	3.6
63.0	--	372	51

(Stenuf 1981)

3.0 LEAD CONCENTRATE

3.1 General Description

Lead concentrate is an intermediate during the production of lead metal from lead containing ores, such as gelena (PbS), anglesite (PbSO4), and cerussite (PbCO3). Lead ores are usually crushed by primary and secondary crushers, followed by wet or dry grinding. The lead mineral is generally separated from the impurities by gravity concentration. Further purification is carried out by selective flotation. The concentrated lead mineral, which contains approximately 15 percent moisture, is commonly referred to as lead concentrate (Kirk-Othmer 1978).

3.2 Chemical and Physical Properties

Lead concentrate is a mixture of lead sulphide, lead sulphate, other metal sulfides and impurities. Physical and chemical properties, and other available data on lead concentrate are shown in Table 3.1.

3.3 Environmental Behaviour

3.3.1 Behaviour of Lead Concentrate in Air

Lead and most of its compounds have negligible vapour pressure at environment temperatures, and the evaporation rate of lead vapour is rather low. They also have a high specific gravity, thus large lead particles will not remain suspended in air for a long period of time. Only extremely small lead particles can be transported by air movements (NRC 1973).

3.3.2 Leachability of Lead Concentrate

Lead concentrates may be spilled during transportation on land and may be leached into the aqueous environment. The leachability of a typical lead concentrate at various pH was studied by Fingas and Poulet in 1984. In their study, two grams of lead concentrate were added to 200 mL of buffered solutions (at pH 4, 5, 6, 7, 8, 9 and 10) and the mixtures were shaken for 24 hours at 15° C. The solids were removed by filtration and the solution analyzed for metal content using atomic absorption. The concentration of lead in the solutions is shown in Table 3.2. The results indicated that more lead is likely to be leached into the solution phase below a pH of 6.

Other factors also affect the leachability of lead concentrate. Iron (+3), which is present in most lead concentrates, was observed to increase the leachability of lead sulphide. Sulphur bacteria could oxidize lead sulphide and liberating lead (+2) (Kirk-Othmer 1978, Jawarski 1979).

3.3.3 Behaviour of Lead in Water

Once lead is leached into the solution phase, it will most likely form complexes with organic ligands and producing soluble, colloidal, and particulate compounds. When not complexed, some of the main species of lead in solution are Pb (+2), and PbCl(+1). The presence of anions, such as phosphate and sulphate, can form salts of low solubility with lead and thus reducing the aqueous lead ion concentration in solution. Theoretical calculations estimated that the solubility of lead in a mixture containing lead, water, carborn dioxide, and sulphur is below 0.001 mg/L between pH of 8.5 to 11. Between pH of 6 and 8, the solubility of lead is a complex function of pH and the amount of dissolved carbon dioxide. Below pH 6.5, lead can be quite soluble in water. Typical total lead concentration in soft water (25 mg/L hardness) is about 0.5 mg/L, whereas it is only 0.03 mg/L in hard water (370 mg/L hardness) (Demayo 1982, NRC 1973).

3.3.4 Lead in Soil

When lead (usually present as lead (+2)) is leached into the soil, it is characterized by its lack of mobility, except in cases where soluble organic complexes are involved or the soil sorption capacity is exceeded. Lead is strongly bonded to clays at a pH higher than 6. Lead retention in the clay is also dependent on the clay type and other metal ions in the clay. Humic substances are found to form complexes with lead in the soil. The total amount of lead fixed by humic substances was observed to decrease almost linearly within a pH range of 8 to 2 (Jaworski 1979, Demayo 1982).

Table 3.1 Available Data for Lead Concentrate

GENERAL

Chemical Name:

lead concentrate (a mixture of lead sulphide, lead sulphate, other metal sulphide and impurities)

Chemical Formula:

lead sulphide - PbS

lead sulphate - PbSO4

Composition:

Elemental Composition of Typical Lead Concentrate:

lead - 45 to 75	zinc - <15
sulphur - 10 to 30	iron - 1 to 8
copper - 0.1 to 3	antimony - 0.1 to 2
silver - <0.15	arsenic - about 0.03
thallium - about 0.01	cadmium - about 0.01
gold - <0.01	mercury - about 0.004
nickel - <0.002	chromium - <0.002
selenium - <0.001	

(Dlouhy 1983, Kirk-Othmer 1978)

Observable Appearance:

dark gray granules (Fingas 1984)

Table 3.1 Available Data for Lead Concentrate (Continued)

Colour:

dark gray (Fingas 1984)

Odour Description:

odourless (Fingas 1984)

Odour Threshold:

N/A

PHYSICAL AND CHEMICAL PROPERTIES

Physical State:

solid at 20°C, 101.3 kPa

Melting Point (°C):

PbS - 1120 (Perry 1984)
1114 (CRC 1984)
1114 (Ullmanns 1974)

PbSO4 - 1170 (Kirk-Othmer 1978)
1170 (Perry 1984)
1170 (CRC 1984)

Boiling Point (°C):

PbS - approx. 1200 (Bailar 1973)

Table 3.1 Available Data for Lead Concentrate (Continued)

Molecular Weight (g/mole):

PbS - 239.25

PbSO4 - 303.25

Density (g/mL):

Pb concentrate (bulk) - 2.79 (Fingas 1984)

PbS - 7.57 to 7.59 (Kirk-Othmer 1978)

PbSO4 - 1.2 (Kirk-Othmer 1978)

Vapour Pressure (kPa):

Pb - negligible at 20°C (NRC 1973)

PbS - approx. 2.7 at 1000°C (Bailar 1973)

Solubility in Water (g/100 mL):

PbS - 0.00009 at 18°C (Perry 1984)

0.000086 at 18°C (CRC 1984)

0.000086 at 18°C (Linke 1965)

PbSO4 - 0.0028 at 0°C (Perry 1984)

0.00425 at 25°C (Kirk-Othmer 1978)

0.00425 at 25°C (CRC 1984)

0.0056 at 40°C (Kirk-Othmer 1978)

0.0056 at 40°C (Perry 1984)

Flotability in Water:

sinks

Table 3.1 Available Data for Lead Concentrate (Continued)

Viscosity (mPa.s):

Pb - 2.12 at 440° C (Kirk-Othmer 1978)

HUMAN HEALTH HAZARDS

Symptoms:

Inhalation and ingestion:

Early signs of acute intoxication: fatigue, disturbance of sleep, and constipation. Severe exposures: colic, anemia, and neuritis (Patty 1981).

Toxicology:

General:

Lead is a cumulative poison. It causes anemia, affects central nervous system, and kidney (Patty 1981)

TLV:

Pb (as dust or fume, inhalation) -

0.15 mg/m**3 (ACGIH 1980)

Table 3.1 Available Data for Lead Concentrate (Continued)

STEL:

Pb (as dust or fume, inhalation) -
0.45 mg/m**3 (ACGIH 1980)

Delay toxicity:

cumulative poison (Patty 1981)

ENVIRONMENTAL HAZARDS

Aquatic Toxicity:

- algal growth is affected by lead (Demayo 1982)
- snail, LC50 (48 hr): 14 to 71 mg lead/L (Demayo 1982)
- rainbow trout, LC50 (96 hr): 1.2 to 1.4 mg dissolved lead/L (Demoya 1982)

Land/air Toxicity:

- Horse, LD: 2.4 mg lead/kg body weight per day (Demayo 1982)

Food Chain:

may be concentrated as lead (Patty 1981)

Table 3.2 Concentration of Lead and Zinc in Leaching Soultions (Fingas 1984)

pH of Leaching Solution	Lead Content	Zinc Content
	(ppm)	(ppm)
4	41	11
5	58	10
6	0.3	0.9
7	0.2	0.2
8	0.4	0.1
9	0.3	0.2
10	1.1	0.06

4.0 ZINC CONCENTRATE

4.1 General Description

Zinc concentrate is an intermediate during the production of zinc metal from zinc containing ores such as sphalerite (ZnS). In the production process, zinc ore is crushed and ground to approximately 75 to 150 um. If the zinc ore contains a significant amount of lead, it is removed by selective flotation first. The zinc ore is then concentrated by a series of flotation operations. The concentrated zinc mineral, which contains approximately 50 to 60 percent zinc, is commonly referred to as the zinc concentrate (Kirk-Othmer 1978).

4.2 Chemical and Physical Properties

Zinc concentrate contains zinc sulphide and other metal compounds. Available chemical and physical properties are summarized in Table 4.1.

4.3 Environmental Behaviour

4.3.1 Behaviour in Air

Since zinc concentrate has a high density, it is not easily transported by wind.

4.3.2 Leachability of Zinc Concentrate

One of the environmental concerns of zinc concentrate is the possibility of introducing zinc ions into the aquatic environment. Fingas and Poulet (1984) studied the amount of zinc released from a typical zinc concentrate sample by adding two grams of the zinc concentrate into 200 mL of buffered solutions maintained at pH 4, 5, 6, 7, 8, 9 and 10. The solutions were shaken for 24 hours at 15°C before the solids were removed by filtration. The filtrates were analyzed for metal content using an atomic absorption technique. The zinc and lead concentrations in the filtrates are shown in Table 4.2. More zinc and lead are detected in the filtrates maintained below a pH of 6, indicating more zinc and lead are likely to be leached into the environment under acidic conditions. A separate study has shown the rate of zinc leaching from suspended zinc sulphide by deionized water was increased by 6 times with the addition of 0.1% humic acid (Spear 1981).

4.3.3 Behaviour in Water

The solubility of zinc sulphide is extremely low with a solubility product of 10**-22. The solubility of zinc was calculated for a fresh water system with 100 mg/L CaCO3 and 0.1 molar dissolved ions. These conditions are

characteristic of water systems in northern Canada, and certain rivers in the east and west coast. Saturated zinc concentrations were predicted to be 10.0, 6.5, 0.65 and 0.01 mg/L at pH 6, 7, 8 and 9, respectively (Spear 1981).

Once zinc ions are leached in the solution phase, they tend to remain as uncomplexed zinc ion molecules instead of forming coordination complexes. When complexes are formed in the absence of other complexing agents, the octahedral structure, (Zn(H2O)6)2, is the preferred form. These coordinated water molecules are replaced by other ligands during complex formation. Stability constants for zinc-inorganic complexes are not readily available nor easily verifiable, and the calculation of dominating species in such a system is extremely difficult under environmental conditions. Zinc generally has a low competition tendency for organic ligants as compared to other divalent cations. Most zinc-organic complexes have a low stability tendency under environmental conditions (Spear 1981).

4.3.4 Behaviour in Soil

Zinc is likely to form stable organic complexes in the soil or sediment. Humic and fulvic acids are suggested to be responsible for solubility and mobility of zinc. Zinc is relatively more mobile in acidic soils. Detailed

information on the behaviour of zinc in soil is not completely elucidated (Spear 1981).

4.4 Environmental Toxicity

4.4.1 Aquatic Toxicity

If zinc is leached into the aquatic environment, the aquo ion $(Zn(H2O)6)2+$ and suspended zinc carbonate $ZnCO3$ have the greatest toxicity. For freshwater fish, zinc has been attributed to the destruction of the gill epithelium and consequent tissue hypoxia. Exposure to relatively high zinc concentration may induce osmoregulatory failure and acidosis. No lethal thresholds have been established for freshwater invertebrates. For marine fish, short-term studies conducted using juvenile and adult life intervals have demonstrated LC50s of 12 to 100 mg/L zinc. The survival of invertebrates is adversely affected by zinc concentrations greater than 0.1 mg/L (Spear 1981).

4.4.2 Food Chain

Zinc concentrations in food are progressively diluted with each upward link in a food chain. Rooted aquatic plants may contain 1.0 mg/g of zinc on a dry weight basis. Invertebrates generally contain 5 to 50 ug/g of zinc on a wet weight basis, or 50 to 300 ug/g on a dry weight basis.

Fish usually contain 4 to 20 ug/g of zinc (wet weight) (Spear 1981).

Table 4.1 Available Data for Zinc Concentrate

GENERAL

Chemical Name:

zinc concentrate (zinc sulphide and other impurities)

Chemical Formula:

zinc sulphide - ZnS

Composition (wt %):

Typical Elemental Composition of Zinc Concentrate:

zinc - 45	sulphur - 30
iron - 11	lead - 2.4
copper - 0.7	arsenic - 0.03
mercury - 0.03	silver - 0.007
cadmium - 0.006	titanium - 0.001
nickel - <0.002	chromium - <0.002

(Dlouhy 1983)

Observable Appearance:

gray granules (Fingas 1984)

Colour:

gray (Fingas 1984)

Table 4.1 Available Data for Zinc Concentrate (Continued)

Odour Description:

odourless (Fingas 1984)

Odour Threshold:

N/A

PHYSICAL AND CHEMICAL PROPERTIES

Physical State:

Solid at 20°C, 101.3 kPa. ZnS has a low-temperature cubic, zincblende form and a high-temperature hexagonal, wurtzite form. The transition temperature is 1020 C. (Bailar 1973)

Melting Point (°C):

ZnS, cubic - transition to hexagonal form at 1020 C (Bailar 1973)

ZnS, hexagonal - 1850 at 150 atmosphere (Perry 1984, Bailar 1973)

Boiling Point (°C):

ZnS - decomposes to ZnO at 930°C (Kirk-Othmer 1978)

ZnS, hexagonal - sublimes at 1185°C (Perry 1984)
sublimes >1180°C (Bailar 1973)

Table 4.1 Available Data for Zinc Concentrate (Continued)

Molecular Weight (g/mole):

ZnS - 97.44

Density (g/mL):

zinc concentrate (bulk density): 1.60 g/mL
(Fingas 1984)

ZnS, cubic - 4.08 (Bailar 1973)
4.102 at 25°C (Perry 1984, CRC 1984)

ZnS, hexagonal - 4.09 to 4.10 (Bailar 1973)
4.087 (Perry 1984)
3.98 (CRC 1984)

Solubility in Water (g/100 mL):

ZnS - 0.000001 to 0.0000001 (Bailar 1973)

ZnS, cubic - 0.000065 at 18°C (CRC 1984)

ZnS, hexagonal - 0.00069 at 18°C (Perry 1984, CRC 1984)

Flotability in Water:

sinks

HUMAN HEALTH HAZARDS

General:

Zinc is not inherently a toxic element (Patty 1981)

Table 4.2 Concentration of Zinc and Lead in Leaching Solutions (Fingas 1984)

pH of Solution	Zinc Content (ppm)	Lead Content (ppm)
4	228	39
5	212	36
6	132	0.1
7	2.6	0.1
8	3.0	0.7
9	12	0.4
10	0.6	0.7

5.0 DRILLING MUD

5.1 General Description

Drilling mud is an integral part of most drilling operations. It is conventionally pumped down the centre of the hollow drilling string, through the ports at the drill bit, up through the annulus formed between the drilling string and the wall of the well and returned to the surface of the well. The formation material is removed from and additives are added to the drilling mud before recycling. The recirculating drilling mud performs the following major fuctions: removing cuttings from the drill string and bit, cooling and lubricating the drill bit, applying hydrostatic pressure to control formation pressure, and consolidating the wall of the well. Drilling mud is generally discharged into the water for an offshore drilling operation or into holding facilities for a land-based operation (BP 1977, Kirk-Othmer 1978, McCourt 1984).

Drilling muds can be divided into five basic types: fresh water, salt water or seawater, oil based, gaseous and clear water drilling muds. Fresh water drilling muds are the most common type in use. Clay or water-soluble polymers may be added to increase the viscosity of fresh water drilling muds. The density of fresh water drilling mud is commonly increased by the addition of clay or barite. Salt

water or seawater drilling muds have become more attractive due to their accessibility in offshore drilling operations. These drilling muds generally contain more additives. Oil based drilling muds are employed for drilling in high temperature wells, water-sensitive shale formations, or where corrosive gases such as hydrogen sulphide and carbon dioxide may be encountered. They are also very effective in reducing torque and pipe sticking problems. A wetting agent is usually used to ensure oil wetting of solids in the mud. Gaseous drilling mud may range from compressed dry air or natural gas to mist or stable foams. Gaseous drilling muds can extend bit life, increase penetration rate, minimize water use, reduce contamination of the environment and minimize core contamination. These drilling muds may not be recycled. Clear water drilling fluids are principally used to eliminate suspension materials in a well and are not generally used for drilling (Zenon 1983, Moore 1974, Kirk-Othmer 1978). Compositions of typical drilling muds are shown in Table 5.1.

Chemical additives are usually added to drilling muds to provide specific properties as required for a particular well. Due to the changing conditions of the well, the properties of the drilling mud are continuously adjusted throughout the drilling operation of a well. An alphabetical listing of available drilling mud additives are tabluated in Appendix A.

5.2 Chemical and Physical Properties

The density of the drilling mud is used to provide a hydrostatic pressure against the formation pressure and to prevent collapse of weak formations into the drill hole. Drilling mud densities vary over a wide range depending on the type of drilling mud and the additives added. Drilling mud viscosity is used mainly to control the circulating pressure drop of the drilling mud. It is controlled by solid content, solid size, temperature and other additives. In addition, since drilling mud is a non-Newtonian fluid, the viscosity is also dependent on shear rate (Moore 1974, Kirk-Othmer 1978). Available data on drilling muds are shown in Table 5.1.

5.3 Environmental Toxicity

The acute toxicity of drilling muds may be caused by a number of individual additives, or the synergistic effects of a number of additives as well as the high level of suspended solids (Osborne 1982).

To elucidate the individual toxicity effect of drilling mud components, Beckett et al (1976) selected rainbow trout as the test species. In their study, only healthy fish stock that had not been treated with antibiotics for two weeks prior to testing or not previously exposed to any toxic

material were used. Feeding was stopped two days before the test. Drilling mud samples were thoroughly mixed and a predetermined amount was added to the test tanks. Mortality checks were taken at 30 minutes, 2, 6, 12, 24, 36, 48, 72 and 96 hours. The test conditions were:

Vessel depth:	10 cm minimum
Fish weight:	2 to 10 grams
Dissolved oxygen:	about 8 mg/L
Water temperature:	15 +/- 2 ^{o}C
Water pH:	6.0 to 9.5
Photoperiod:	12 hours
Fish per test:	10

The toxicity results for the individual drilling mud additives are summarized in Table 5.1. Toxicity data of other drilling mud additives used in the Canadian offshore may be found in COGLAMUD, the Canada Oil and Gas Lands Administration computerized database (McCourt 1984).

The toxicity of actual drilling mud mixtures were studied by several investigators. Weir et al (1976) exposed rainbow trout to 96-hour static tests using drilling muds obtained at different time periods from the Imperial Oil's artificial island Immerk B-48 in the Beaufort Sea. Detailed test conditions were:

Rainbow trout weight:	2 to 10 grams
Number of fish/vessel:	5
Volume of vessel:	20 liters
Time of mortality check:	1, 2, 4, 6, 12,18,24,26,48,60, 72, 84 and 96 hours
Test temperature:	15 +/- 1.5°C
Aeration rate:	250 to 1000 mL/minute
Degree of replication:	2
Water pH:	7.4 to 7.8
Water hardness:	90 to 100 mg/L CaCO3

The toxicity test results are shown in Table 5.1

"Whole" drilling mud from an active mud system of an exploratory drilling operation from the Tuktoyaktuk Peninsula-MacKenzie Delta region was studied by Didiak and Wright (1976). This drilling mud was composed primarily of bentonite, barite, ferro-chrom lignosulphonate and caustic soda. The test organism was the third instar larvae of the chironomid (chironomus tentans). The study was divided into two parts: a preliminary viability study to elucidate initial reaction of the organism to a layer of drilling fluid; and a quantitative assessment of the chronic effects of the waste on the growth, metamorphosis and emergence as an adult of the organism. Both parts of the study were conducted using a substrate of 4 mm thick fine silica sand. A photoperiod of 9 hours (at an illumination intensity of

1500 lux) was allowed for a 24-hour cycle. Water at a depth of 12 cm was adjusted to a test temperature of 20°C, a pH of 7.8 and a total hardness of 100 mg/L as CaCO3. The organisms were fed with commercial tropical fish food.

The viability experiment was undertaken in four glass aquaria (5.5 liters capacity), with the following experimental sequence: the aquaria were aerated for 24 hours, the larvae were introduced, the test organisms were allowed to acclimate for four days, the drilling mud was added to three aquaria (at 1, 3 and 7 mm thick), and the organism removed for study after 48 hours. The results suggested that drilling mud in excess of 1 mm may constitute a formidable barrier to the establishment of burrows by the larvae and may impair the recolonization of a substrate contaminated by drilling mud.

The emergence experiment was carried out in twenty individually-aerated chambers. The experimental procedure was: 24 hours of aeration; introduction of larvae; 72 hours of acclimation period; addition of drilling mud to 15 of the chambers (at 1, 3 or 7 mm thick); exuviae (pupal skins) floating on the water surface (used to indicate emergence of adult midge) of each chamber were counted and removed daily for 29 days; and the organisms were removed for observation. The results indicated the survival and emergence as adults was considerably reduced by the

presence of drilling mud. The adult emergence percent for the control chamber, the chambers treated with 1, 3 and 7 mm of drilling mud were 84.4, 62, 47 and 12 percent, respectively. The period of maximum emergence in the treated chambers was delayed as compared to the control.

Moore et al (1976) carried out a one-year program to determine the acute toxicity of drilling muds from selected exploratory Arctic rigs to rainbow trout. A 96-hour static bioassay, without replacement, was performed at the following conditions:

Test temperature:	15°C
Water conditions:	
pH:	7.0 to 8.0
CaCO3:	70 to 80 mg/L
Total residual Cl2:	<0.02 ppm
Free Cl2:	<0.01 ppm
Dissolved O2:	>60% of saturation
Test Containers:	
Material:	polyethylene
Shape:	cylindrical

The test procedure was:

- quarantined all test species for a minimum of two week at 10°C

- adjusted water temperature to 15°C
- stopped feeding 2 days before bioassay
- added drilling mud to test tank and adjusted water pH to within 6 and 9.5
- performed mortality checks at 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 12 and 24 hours using nylon mesh brackets to raise the fish.

The bioassay results are summarized in Table 5.1. It was concluded that metal chlorides, in particular potassium chloride, contributed greatly to the toxicity of drilling fluids. When low toxicity materials such as bentonite and barite are combined with several organic polymers (used to increase mud viscosity), the toxicity level of the mud system is increased. Many specialty products are important sources of toxicity in the mud system.

The acute toxicity of seven Arctic drilling fluids on rainbow trout, coho salmon and four intertidal invertebrate species (worms, clams, crabs and shrimp) was determined in freshwater and seawater 96-hour LC50 static bioassays (McLeay 1976). Test Conditions were:

Test temperature:	12°C
Dissolved oxygen:	>9.0 mg/L
Photoperiod:	12 hours (fluorescent light)

Vancouver city tap water was used as dilution water (residual chlorine <0.005 mg/L). Seawater from the Burrard Inlet, which was kept aerated during a maximum of 4 days of storage, was used. A summary of the test results are shown in Table 5.1. It was found that the order of toxicity of drilling fluids to each test animal was not consistent, which may be attributed to variations in the nature of toxic constituents (and site of action) between samples. The acute toxicity of six drilling fluids to freshwater and seawater-acclimated coho salmon (in freshwater and seawater) was similar.

Table 5.1 Available Data for Drilling Mud

GENERAL

Composition (g/L):

Typical composition of drilling mud:

a) fresh water drilling mud:

- water	500	to	1000	
- bentonite	40	to	80	
- lignosulphonate	6	to	30	
- lignite	3	to	15	
- caustic	1.5	to	4	
- barite	0	to	1500	

b) salt water drilling mud:

- water	500	to	1000	
- sodium chloride	250	to	350	
- attapulgite	75	to	100	
- starch	7.5	to	15	
- sodium chromate	1.5	to	3	
- formaldehyde	0.5	to	1.5	

c) oil based drilling mud:

- medium gravity oil to diesel	400	to	650	
- water	100	to	150	
- calcium chloride	40	to	70	
- emulsifier	15	to	60	
- amine clay	6	to	12	
- amine lignite	0	to	30	
- barite	0	to	1500	

d) gaseous drilling mud:

- bentonite	78	to	94	wt%
- foamer (soap)	2	to	10	wt%
- sodium chromate	2	to	8	wt%
- sodium carboxymethyl cellulose	2	to	4	wt%

e) clear water drilling mud:
zinc bromide, calcium bromide, calcium chloride and sodium chloride may be applied up to the maximum solubility

(Zenon 1983)

Table 5.1 Available Data for Drilling Mud (Continued)

ENVIRONMENTAL HAZARDS

Aquatic Toxicity:

1) Drilling mud additives - LC50 (96-hour) of rainbow trout in fresh water ($CaCO_3$ of 70 to 80 mg/L) at 10 C (ppm):

a) Weighting Agent:	
- Barite (barium sulphate):	>100,000
- Calcium carbonate:	>56,000
b) Viscosifiers:	
- Wyoming bentonite:	>50,000
- Attapulgite:	23,000
- Kelzan X-C polymer (xanthan gum):	1,800 to 2,000
- FLR-100 (organic polymer):	2,200 to 4,000
- Visbestos (asbestos):	2,750
c) Extenders for Bentonite:	
- Benex (copolymer of polyvinyl acetate and malic anhydride):	1,300
- Rapidril (organic polymer):	550
- Kwik-Vis (polymer):	1,600
- Drillaid 421 (organic polymer):	280 to 550
d) Thinners (Dispersants):	
- Peltex (ferro-chrome lignosulphonate):	3,000 (pH neutralized)
- Q-Broxin:	1,500 to 2,000
- Spersene:	2,500 to 5,000
- Uni-Cal (chrome modified sodium lignosulphonate):	860
- DFE-506 (ferrous lignosulphonate) :	3,500 (pH neutralized)
- Carbonox (lignite):	6,500
- Calcium lignosulphate:	>2,000
- Mil-Flo (hemlock bark extract):	600
- Desco (organic extract):	1,200
e) Alkalinity (pH) Control:	
- Caustic soda (sodium hydroxide):	105
- Caustic potash (potassium hydroxide):	105
- Lime (calcium hydroxide):	50
f) Lost Circulation Control:	
- Kwik -Seal (wood fiber & cellophane):	random
- Walnut shells:	2,800 (stirred) 5,500 (settled)

Table 5.1 Available Data for Drilling Mud (Continued)

1) continued	
g) Preservatives:	
- Paraformaldehyde:	60
- Dowicide-B (sodium trichlorophenate):	<1.0
h) Salts:	
- Sodium chloride:	10,000
- Muriate of potash:	2,100
- Calcium chloride:	10,000
i) Corrosion Inhibitors:	
- sodium chromate:	160
j) Defoamers:	
- aluminum stearate:	1,100
- capryl alcohol:	83
k) Calcium Removers	
- Bicarbonate of soda (sodium bicarbonate):	7,500
- S.A.P.P. (sodium acid pyrophosphate):	1,700
- Soda ash (sodium carbonate):	75
l) Fluid Loss Reducers:	
- C.M.C. (sodium carboxymethyl cellulos):	3,000
- Cypan (sodium polyacrylate):	1,200 to 1,300
- Drispac (polyanionic cellulose):	2,700 to 2,800
- Dextrid (organic polymer):	<1
m) Shale Inhibitor:	
- D.A.P. (diammonium phosphate):	14,500 to 58,000
- Protectomagic (blown asphalt):	50,000 to 75,000
n) Special Products:	
- Plaster of Paris (gypsum):	>56,000
- Potassium chrome alum (chromalit):	>730
- BaraFloc (clay flocculant):	800
- Swift's rig wash (detergent):	22
- Dominion rig wash (detergent):	14
- Amway rig wash (detergent):	0.8
- V-Wis rig wash (detergent):	58
- Gracco (detergent):	100 to 200
- Ivory Snow (detergent):	154

(Bryant 1976, Beckett 1976)

Table 5.1 Available Data for Drilling Mud (Continued)

2) Drilling Mud Mixtures - LC50, 96-hr of Rainbow Trout in fresh water ($CaCO_3$ of 90 to 100 mg/L) and 15 C:

Sample Description	LC50 (96-hr) (vol %)
KCl or surface hole drilling mud from mud tank	17.3
KCl or surface hole drilling mud from jet mixed supersump tank	22
Desilter underflow (rejects) from jet mixed supersump tank	29
Drilling mud with high solids content from sand traps	43
Weighted drilling mud waste from jet mixed supersump tank	25.5 to 59
Final drilling mud from mud tank	3.25
Drilling mud from flowline (from wellbore)	7.6
Drilling mud from desilter overflow	14.5
Drilling mud from Sweco overflow	12.5

(Weir 1976)

Table 5.1 Available Data for Drilling Mud (Continued)

3) Drilling Mud Mixtures - LC50, 96-hr of Rainbow Trout in freshwater ($CaCO_3$ of 70 to 80 mg/L) and 15 C:

Well Identification and Mud Type	Drilling Depth	LC50 (96-hr) Rainbow Trout (vol %)
Imperial-Pullen E-17	0 to 3,000	10
	4,000 to 9,000	36 to 70
	10,000	16
	11,000	9
	12,000	15
	13,000	9
Aquitaine-Polar Bear 0-20	600	>100
	600 to 4,900	<25
Sun-Pelly B-35 (KCl- or Gel-polymer mud)	1,300	3.5
	3,500	5
	7,650	11
	9,760	3.9
Shell-Niglintgak M-19 (weighted polymer mud)	4,000	4.5
	10,375	4
Shell-Kipnik 0-20 (KCl-polymer mud)	5,680	12
Chevron-Upluk M-38 (weighted Gel XC polymer mud)	11,150	9.5
Pan Arctic-Chad's Creek B-64 (Gel XC polymer mud)	9,620	55
Pan Arctic-Pym Point C-44 (Gel XC polymer mud)	3,250	0.29

(Moore 1976)

Table 5.1 Available Data for Drilling Mud (Continued)

4) Drilling Mud Sustems - LC50, 96-hours of Rainbow Trout, Coho Salmon, Worm, Clam, Crab, and Shrimp:

Drilling Mud Type	Dilution Water	LC50, 96-hr of Test Organism (vol %) Rainbow Trout	Coho Salmon	Worm
KCl Polymer	freshwater	3.3 - 5.9	-	-
	seawater	1.8 - 3.2	1.8 - 3.2	2.8 - 4.5
Seawater Polymer	freshwater	10.0 - 18.0	10.0 - 18.0	-
	seawater	-	10.0 - 18.0	17 - 28
KCl-XC Polymer	freshwater	2.6 - 4.4	1.6 - 2.6	-
	seawater	-	1.8 - 5.6	3.2 - 5.6
Weighted Polymer	freshwater	1.0 - 1.8	0.3 - 0.6	-
	seawater	-	1.2 - 1.9	1.6 - 3.2
XC-Gel Polymer	freshwater	3.2 - 5.6	1.8 - 2.9	-
	seawater	-	2.7 - 5.7	>56.0
Weighted XC-Gel Polymer	freshwater	1.4 - 2.3	1.8 - 3.2	-
	seawater	-	14.0 - 23.7	22 - 45
XC-Gel Polymer	freshwater	3.2 - 5.6	1.8 - 3.2	-
	seawater	-	2.4 - 3.8	16 - 25

Table 5.1 Available Data for Drilling Mud (Continued)

4) continued

Drilling Mud Type	Dilution Water	LC50, 96-hr of Test Organism (vol %) Clam	Crab	Shrimp
KCl Polymer	freshwater - seawater	3.2 - 5.6	4.2 - 5.7	-
Seawater Polymer	freshwater - seawater	24.9 - 41.2	45.4 - 61.8	18 - 32
KCl-XC Polymer	freshwater - seawater	4.4 - 7.1	5.6 - 10.0	1.0 - 1.8
Weighted Polymer	freshwater - seawater	0.8 - 1.3	4.9 - 7.9	2.6 - 4.4
XC-Gel Polymer	freshwater - seawater	>56.0	>56.0	6.0 - 11
Weighted XC-Gel Polymer	freshwater - seawater	>56.0	44 - 71	34 - 58
XC-Gel Polymer	freshwater - seawater	>56.0	>56.0	>56.0

(McLeay 1976)

6.0 LATEX RUBBER

6.1 General Description

Latex rubber is a colloidal aqueous emulsion of natural or synthetic polymers, and it is an intermediate for the production of latex paints and other products. There are three major types of latex rubbers: natural, synthetic, and artificial. Natural latex rubber is the milky exudate of certain trees and plants, of which only Hevea brasiliensis tree is of major commercial importance. Freshly tapped natural latex rubber is generally stabilized by ammonia as soon as it is produced. The fresh latex solution usually contain about 38 percent of solids. It is concentrated into a marketable form of about 61 to 64 percent solids by centrifuge or by the addition of a creaming agent followed by skimming (Kirk-Othmer 1978, Morton 1973).

Synthetic latex rubber is mainly prepared from emulsion polymerization of butadiene-styrene, butadiene-acrylonitrile, butadiene-styrene-acrylonitrile and chloroprene (neoprene). There are also a number of special synthetic latices that are prepared from a combination of the above polymers. For a generalized batchwise emulsion polymerization process, the monomer feed is scrubbed by a cleaning solution to remove impurities and polymerization

inhibitors. Emulsifiers, catalysts, modifiers, the monomer feed, and process water (usually deionized water) are mixed together or emulsified before entering the reactor or a series of reactors where polymerization takes place in the solution phase. The temperature of the reactors is maintained at approximately 5 C for a cold latex process. After polymerization is completed, the latex is removed from the reactors and stabilized. Unreacted feed is generally removed by stripping or condensation. Particles larger than the specified size are removed by screens. The latex may be blended and additives may be added before it is ready for shipment (Sittig 1975).

Artificial latex rubber is prepared from the dispersion of reclaimed rubber, butyl rubber, cis-polyisoprene, cis-polybutadiene, or ethylene-propylene terpolymers. (Kirk-Othmer 1978).

Generally, latex rubbers are formulated in the solution phase before product formation. Stabilizers, dispersing agents, wetting agents, antioxidants and other additives may be dispersed into a emulsion before addition to the latex rubbers. Product formation may be carried out by electrodeposition, coagulant deposition and the Kaysam (using porous molds) processes. Other product configurations (such as threads, latex foams, carpet

backsizings, and paper coatings) may require specific formation processes (Kirk-Othmer 1978).

6.2 Chemical and Physical Properties

Freshly tapped natural latex rubber has a pH of 6.5 to 7.9. It has a surface tension of approximately 40 mN/m and a solid content of about 36 percent. The polymer is primarily cis-1,4-polyisoprene. Enzymes and bacteria lower the pH of fresh latices, which will cause them to coagulate in a short time. Ammonia is the most common preservative used to keep the latices in a stable colloidal form. Natural latex rubber contains proteins and phospholipids (Kirk-Othmer 1978, Morton 1973).

Synthetic latex compounds are generally classified by the type of polymer structures. Styrene-butadiene latices are the most common types. They are produced with various polymerization processes using a large number of different soaps and surfactants. The resulting latex products have a wide variety of properties. Vinyl acetate latices are principally used to manufacture latex paints and adhesives. The acrylic latex compounds are generally produced as copolymers of methyl or ethyl methacrylate and other monomers such as styrene and vinyl acetate. Nitrile and polychloroprene latices are less commonly used except for specific applications (Morton 1973).

Many additives are required to provide the desired properties of a latex product. Sulphur is the most common vulcanizing agent used to improve the strength of latex rubbers. Generally, zinc oxide is added to accelerate the vulcanization process. Fillers such as clays are used to reduce cost, but they do not provide reinforcement for the final latex products. Many thickeners are used: silica, protein, starch, sodium polyacrylates and polyvinyl-methylether. Nondiscolouring and nonstaining phenolic antioxidants are most attractive to latex rubber formulations. Waxes may be used as they tend to rise to the surface of the latex thus forming a protective coating. Synthetic latices may contain more additives than natural latex rubbers. A 5 to 10 weight percent of emulsifiers in the formulation is not considered unusual. The most common emulsifiers are sodium, potassium, or ammonium salts of oleic acid, stearic acid, rosin acid, or disproportionated rosin acid. Some commercial examples are: sodium lauryl sulfate, potassium oleate and stearyl dimethyl benzyl ammonium chloride. The type and amount of additives used depends on the type of latex and the application involved (Kirk-Other 1978, Morton 1973). Available information on latex rubber is shown in Table 6.1.

6.3 Environmental Behaviour

After a latex rubber solution is spilled on land moisture in the latex solution is expected to evaporate quickly, thus forming a rather inert rubbery polymer. If a latex rubber solution is spilled in water, it will dissolve. Latex rubber solutions are generally not reactive with water or most common materials (Weiss 1980).

Latex rubbers are considered to be a mixture of low toxicity (TSB 1984). Addition of acids or heating may coagulate latex rubber solutins, resulting in a more flammable substance (Weiss 1980).

Table 6.1 Available Data for Latex Rubber

GENERAL

Composition (wt %):

Typical composition of natural latex rubber:

total solid	61.5 to 64.0 wt %
dried rubber content	60.0 to 62.0 wt %
water-soluble matter	0.23 wt % of rubber
nitrogen	0.36 wt % of rubber

(Kirk-Othmer 1978)

Typical styrene-butadiene rubber latex:

total solid	45 to 55 %

(Sittig 1975)

Typical nitrile rubber latex:

total solid	45 to 55 %

(Sittig 1975)

Colour:

Natural latex rubber: milky (Kirk-Othmer 1978)

Odour Description:

Each latex rubber has a characteristic odour (Weiss 1980)

Table 6.1 Available Data for Latex Rubber (Continued)

Particle Size:

Latex particles ranged from 0.05 to 5 um (Morton 1973)

CHEMICAL AND CHEMICAL PROPERTIES

Physical State:

Liquid at room temperature (TSB 1984)

Density (g/mL):

Liquid: 1.056 at $^{\circ}$25 C (Weiss 1980)

FIRE HAZARDS

Behaviour in Fire:

Typical latex rubber solution may coagulate by acids or heating and become flammable. Combustion products may include hydrochloric acid, hydrogen cyanide and styrene gases (Weiss 1980)

7.0 LATEX PAINT

7.1 General Description

A latex paint is a suspension of high molecular weight polymer particles, pigments and other additives in an aqueous medium. The manufacturing process is composed of a series of mixing operations generally starting with latex rubber solutions. The ingredients are weighed and poured into a mixing tank where thorough mixing takes place. The suspension is then fed continuously into a grinding mill before being discharged into another mixing tank. Thinners and other additives may be added at this stage. The final product is stored in hoppers prior to packaging and shipment (Kirk-Othmer 1978, Austin 1984).

7.2 Chemical and Physical Properties

The discrete, small particles of high molecular weight polymers used in latex paints are commonly vinyl acrylics, polyvinyl acetate and acrylics. These polymers have very few functional groups and they required dispersing agents to assist in the stability of the latex suspension. Nonionic or anionic surfactants are commonly used. Pigments are selected to provide proper hiding, colour and gloss. Titanium dioxide is a commonly used white pigment. Coalescing solvents must be added to plasticize the latex

temporarily during film formation. These coalescents are usually water-miscible solvents, such as ethers or glycols. Thickeners must be used to improve the storage, application and flow characteristics of latex paints. Cellulosic thickeners are most commonly used. Ideally, the viscosity of the latex paint should be high during storage to prevent settling of the pigments. However, the viscosity of latex paints should be low when it is being applied to a surface so that the paint can be spread satisfactorily. Fillers are added to reduce production cost of latex paints, and they generally inprove its durability. Some examples are: clays, calcium carbonates, silicates, diatomaceous earth and talcs. Other additives may be required for agglomeration prevention, foam reduction, and pH adjustment. In general, the total volatile organic compounds in latex paints is maintained below 250 g/L. Total lead content is limited at 0.06 percent (Kirk-Othmer 1978, Martens 1981). Typical composition of several latex paints are shown in Table 7.1

7.3 Environmental Behaviour

Latex paints expected to behave similar to latex rubber solutions.

Table 7.1 Available Data for Latex Paints

COMPOSITION:

1) Typical white interior flat polyvinyl acetate/ ethylene copolymer latex paint:

Components	Wt %
polyvinyl acetate latex (55% solution)	22.2
methyl cellulose (2% solution)	24.5
titanium dioxide	17.4
clay	13.1
water	11.6
whiting	4.4
propylene glycol	2.2
diatomaceous silica	2.2
defoamer	0.9
dispersing agent	0.8
2-amino 2-methyl-1-propanol	0.3
surfactant	0.3
potassium tripolyphosphate	0.1
fungicide	0.04

Table 7.1 Available Data for Latex Paints (Continued)

2) Typical white semigloss interior acrylic latex paint:

Components	Wt %
acrylic latex (46.5% solution)	44.6
titanium dioxide	22.6
propylene glycol	15.4
hydroxyl ethyl cellulose	5.2
barytes	4.5
water	4.5
butyl cellosolve	1.2
dispersant	1.0
defoamer	0.4
surfactant	0.2
preservative	0.2
fungicide	0.05

Table 7.1 Available Data for Latex Paints (Continued)

3) Typical white exterior acrylic latex paint:

Components	Wt %
acrylic latex (50% solution)	32.6
titanium dioxide	19.8
talc	15.7
water	10.6
hydroxyethyl cellulose (2.5% solution)	7.1
zinc oxide	4.2
propylene glycol	2.8
long oil alkyd	2.6
ethylene glycol	2.1
dispersant	1.1
tributyl phosphate	0.8
fungicide (45% solution)	0.2
defoamer	0.2
potassium tripolyphosphate	0.1
ammonium hydroxide (28% solution)	0.1

(Martens 1981)

8.0 PHOSSY WATER

8.1 General Description

The process water that comes in contact with white phosphorus during the manufacturing of elemental white phosphorus, and the blanket water used for storage and transportation of white phosphorus is generally referred to as phossy water (Kirk-Othmer 1978, Sullivan 1979).

8.2 Chemical and Physical Properties

Phossy water contains significant quantities of colloidal and large-size white phosphorus particles along with dissolved elemental phosphorus. High concentrations of orthophosphate and other phosphorus oxides may be present. Fluoride, ammonia, silicates and cyanide may also result from commercial preparation (Sullivan 1979).

8.3 Behaviour in Water

Phossy water, which contains dissolved, colloidal, and suspended phosphorus, is not a stable mixture in the environment. The dissolved and suspended phosphorus reacts with dissolved oxygen and hydroxide ion to form various phosphorus oxides, acids and phosphine (PH_3). Unreacted phosphorus particles may settle out and can be incorporated

into aquatic sediments. The data on the kinetics and decomposition products of phosphorus in water are poorly defined. Reported rates of oxidation of phosphorus in water vary greatly and are dependent on pH, dissolved oxygen content, temperature, metal ions and on the degree of dispersion of colloidal or suspended phosphorus (Sullivan 1979).

8.4 Environmental Toxicity

Toxicity data on phossy water are summarized in Table 8.1.

The delayed but inevitable death of aquatic organisms exposed for short periods at high concentrations, or exposed for long periods at very low concentrations, of dissolved or suspended phosphorus in water suggests that phosphorus is bioaccumulative. The concentration of phosphorus in some organisms was observed to be 42 times higher than the water concentration. However, these organisms quickly lost their accumulated phosphorus content after being transferred to clean water (Sullivan 1979)

Table 8.1 Available Data for Phossy Water

AQUATIC TOXICITY:

1) Bluegill (Lepomis macrochirus), LC50 (96-hr):
   4 to 86 ug/L as P4 (Sullivan 1979)
2) Fathead Minnow (Pimephales promelas), LC50 (96-hr):
   18 to 154 ug/L as P4 (Sullivan 1979)
3) Rainbow Trout (Salmo gairdneri), LC50 (96-hr):
   22 ug/L as P4 (Sullivan 1979)
4) Mosquito Fish (Gambusia affinis), LC50 (96-hr):
   63 ug/L as P4 (Sullivan 1979)
5) Atlantic Herring (Clupea harengus), LC50 (96-hr):
   approximately 3.7 ug/L as P4 (Sullivan 1979)

FOOD CHAIN:

Bioaccumulative (Sullivan 1979)

9.0 REFERENCES

ACGIH 1980
Anonymous, "Documentation of the Threshold Limit Values", 4th ed., American Conference of Governmental Industrial Hygienists Inc., Cincinnati (1980).

Austin 1984
Austin, G.T., "Shreve's Chemical Process Industries", 5th ed., McGraw-Hill Book Company, New York (1984).

BP 1977
British Petroleum Co. Ltd., "Our Industry Petroleum", 5th ed., London, England (1977).

Bailar 1973
Bailar, L.C. Jr., Emeleus, H.J., Nyholm, R., & Trotman-Dickenson, A.F., editors, "Comprehenxive Inorganic Chemistry", Pergamon Press, Oxford (1973).

Beckett 1976
Beckett, A., Moore, B. and Weir, R.H., "Acute Toxicity of Drilling Fluid Components to Rainbow Trout", in Industry/Government Working Group in Disposal Waste Fluids from Petroleum Exploratory Drilling in the Canadian North, Vol. 9 (1976).

Beckwith 1981
Beckwith, W.F., Kasbohm, D.L., & Hassler, J.C., "Analysis of Black Liquor by Thermogravimetry and Gas Chromatography", AIChE Symposium Series on the Use and Processing of Renewable Resources, No. 207, Vol. 77, Pg. 68-72 (1981).

Bruley 1974
Bruley, A.J., "The Basic Technology of the Pulp and Paper Industry and its Waste Reduction Practices", Environmental Protection Service, Environment Canada, Training Manual No. EPS 6-WP-74-3 (1974).

Bryant 1976
Bryant, W.J., et at, "Interim Guidelines for Disposal of Waste Fluids from Petroleum Exploratory Drilling in the Canadian North", Summary report by Industry/Government Working Group "A", Vol. 1 (1976).

CRC 1984
Weast, R.C., Astle, M.J. & Beyer, W.H., editors, "CRC Handbook of Chemistry and Physics", CRC Press, Inc., Florida (1984).

Demayo 1982
Demayo, A., Taylor, M.C., Taylor, K.W. & Hodson, P.V., "Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife Plants and Livestock", CRC Critical Reviews in Environmental Control, Vol. 12, Iss. 4, pg. 257-305 (1982)

Dhaneshwar 1970
Dhaneshwar, R.S., Rajagopalan, S., Basu, A.K., & Rao, C.S.G., "Characteristics of Wastes from Pulp and Paper Mills in the Hooghly Estuary", Environmental Health, Vol. 12, Pg. 9-23 (1970).

Didiak 1976
Didiak, A. & Wright, D.G., "The Effect of a Drilling Waste on the Survival and Emergence of the Chironomid", Industry/ Government Work Group in Disposal Waste Fluid from Petroleum Exploratory Drilling in the Canadian North, Vol 12 (1976).

Dlouhy 1983
Dlouhy, J.F., "Analysis of Lead and Zinc Ore Concentrates", Internal Report, Analytical Services Division, Technical Services Branch, Environment Canada (1983).

EETD 1984
Experimental Data from Environmental Emergencies Technology Division, Environmental Protection Service, Environment Canada (1984).

Fingas 1984
Fingas, M.F., & Poulet, M.H., "Leaching of Lead and Zinc Concentrates", Internal Report, Environmental Emergencies Technology Division, Environment Canada (1984).

Idler 1969
Idler, D.R., "Coexistence of a Fishery and a Major Industry in Placentia Bay", Chem. Can. V21, page 16-21 (1969).

Jaworski 1979
Jaworski, J.F., "Effects of Lead in the Environment - 1978. Quantitative Aspects", National Research Council of Canada, NRCC No. 16736 (1979).

Kirk-Othmer 1978
Mark, H.F., Othmer, D.F., Overberger, C.G. & Seaborg, G.T., "Kirk-Othmer Encyclopedia of Chemical Technology", 3rd ed., John Wiley & Sons, New York (1978).

Langenkamp 1980
Langenkamp, R.D., "The Illustrated Petroleum Reference Dictionary", Petroleum Publishing Co. (1980).

Lee, E.G-H., Mueller, J.C., Walden, C.C., & Stich, H., "Mutagenic Properties of Pulp Mill Effluents", Pulp and Paper Canada, Vol. 82, No. 5, Pg. 69-76 (1981).

Linke 1965
Linke, W.F., "Solubilities, Inorganic and Metal-organic Compounds", 4th ed., American Chemical Society, Washington, D.C. (1965).

MacDonald 1969
MacDonald, R.G., & Franklin, J.N., eds., "Pulp and Paper Manufacture", Vol. 1 of The Pulping of Wood, 2nd ed., McGraw-Hill Book Co., New York (1969).

Marier 1973
Marier, J.R., "The Effects of Pulp and Paper Wastes, with Particular Attention to Fish and Bioassay Procedures for Assessment of Harmful Effects", National Research Council Canada, NRCC Publication No. 13501 (1973).

Martens 1981
Martens, C.R., "Waterborne Coatings, Emulsion and Water-Soluble Paints", Van Nostrand Reinhold Company, New York (1981).

McCourt 1984
McCourt, J.P., Hardie, D, Chenard, P., "Toxicity Testing of Drilling Fluid Additives Used in the Canadian Offshore - A Perspective", Canadian Oil and Gas Lands Administration, Environmental Protection Branch Technical Report No. 1 (1984).

McLeay 1976
McLeay, D.J., "Marine Toxicity Studies on Drilling Fluid Wastes", Industry/Government Working Group in Disposal Waste Fluids from Petroleum Exploratory Drilling in the Canadian North, Vol. 10 (1976).

Moore 1974
Moore, P.L., "Drilling Practices Manual", Petroleum Publishing Co. (1974).

Moore 1976
Moore, B., Beckett, A., & Weir, R.H., "Acute Toxicity of Drilling Fluids to Rainbow Trout", Industry/Government Working Group in disposal Waste Fluids from Petroleum Exploratory Drilling in the Canadian North, Vol 8 (1976).

Morton 1973
Morton, M., ed., "Rubber Technology", 2 ed., Van Nostrand Reinhold Company, New York (1973).

NRC 1973
Anonymous, "Lead in the Canadian Environment", NRC Publication No. 13682 (1973).

Oilweek 1983a
Anonymous, "1984 Guide to Drilling Fluids", Oilweek, Dec 5th (1983).

Osborne 1982
Osborne, J., "Review of Acute Lethality of Waste Drilling Fluids", in Report on Offshore Oil & Gas Drilling Fluid Disposal in the Canadian North, by An Indusrtry/Government Steering Committe and Working Group (1982).

Patty 1981
Clayton, G.D., & Clayton, F.E., editors, "Patty's Industrial Hygiene and Toxicology", 3rd ed., John Wiley & Sons, New York (1981)

Perry 1984
Perry, R.H., Green, D.W., & Maloney, J.O., editors, "Perry's Chemical Engineers' Handbook", 6th ed., McGraw-Hill, New York (1984).

Rai 1976
Rai, C., & Tran, D.Q., "Recovery of Medium to High BTU Gas from Bark and Black Liquor Concentrates", AIChE Symposium Series on Chemical Engineer in Pulp and Paper Technology, No. 157, Vol. 72, Pg. 100-111 (1976).

Ranney 1979
Ranney, M.W., "Crude Oil Drilling Fluids", Noyes Data Corporation, New Jersey (1979).

Sittig 1975
Sittig, M., "Pollution Control in the Plastics and Rubber Industry", Noyes Data Corporation, New Jersey (1975).

Sjostrom 1981
Sjostrom, E., "Wood Chemistry - Fundamentals and Applications", Academic Press, New York (1981).

Sjostrom 1983
Sjostrom, E., "Production of Chemicals from Wood as an Integrated Part of the Pulping Process", 1983 International Symposium on Wood and Pulping Chemistry, Vol. 3, Pg. 57-62 (1983).

Stenuf 1981
Stenuf, T.J., & Agrawal, M.L., "Viscosity of Black Liquor", AIChE Symposium Series on the Use and Processing of Renewable Resources, No. 207, Vol. 77, Pg. 14-17 (1981).

Spear 1981
Spear, P.A., "Zinc in the Aquatic Environment: Chemistry, Distribution and Toxicology", Associate Committee on Scientific Criteria for Environmental Quality, National Research Council Canada (1981).

Sullivan 1979
Sullivan, J.H., Jr., Putnam, H.D., Keirn, M.A., Pruitt, B.C., Jr., Nichols, J.C. & McClave, J.T., "A summary and Evaluation of Aquatic Environmental Data in Relation to Establishing Water Quality Criteria for Munitions-unique Compounds. Part 3: White Phosphorous", final report, U.S. Army Medical Research & Development Command (1979).

TSB 1984
Anonymous, "Manual for Spills of Hazardous Materials", Technical Services Branch, Environment Canada (1984).

Tver 1980
Tver, D.F. & Berry, R.W., "The Petroleum Dictionary", Van Nostrand Reinhold Co., New York (1980).

Ullmanns 1974

"Ullmanns Encyklopadie der technischen Chemie", Verlag Chemie GmbH, Weinheim/Bergstr. (1974).

Van Wazer 1961
Van Wazer, J.R., "Phosphorous and its Compounds. Volume 2: Technology, Biological Functions and Applications", Interscience Publishers, Inc., New York (1961).

Weir 1976
Weir, R.H., Lake, W.H. & Thakeray, B.T., "Acute Toxicity of Discharged Drilling Mud from Immerk B-48, Beaufort Sea to Rainbow Trout, Salmo Gairdneri", Industry/Government Working Group in Disposal Waste Fluids from Petroleum Exploratory Drilling in the Canadian North, Vol. 6 (1976).

Weiss, G., ed., "Hazardous Chemicals Data Book", Noyes Data Corporation, New Jersey (1980).

Zenon 1983
Zenon Environmental Enterprises, Ltd., "Environmental Review of Onshore Canadian Oil and Gas Drilling and Production Activities", for the Environmental Protection Services, Environment Canada, Report No. EPS 3-EP-83-2 (1983).

APPENDIX A

PRODUCT NAME, DESCRIPTION, FUNCTIONS, SYSTEMS USED IN AND DISTRIBUTORS OF DRILLING MUD ADDITIVES

Legend

Function Codes:

1 = pH control agents
2 = bactericides
3 = calcium removers
4 = corrosion inhibitors
5 = defoamers
6 = emulsifiers
7 = filtrate reducers
8 = flucculants
9 = foaming agents
10 = lost circulation control agents
11 = lubricants
12 = shale control inhibitors
13 = surface active agents
14 = thinners or dispersants
15 = viscosifiers
16 = weight control agents

Systems-Used-In Codes:

a = nondispersed fresh water drilling muds
b = dispersed fresh water drilling muds
c = inhibited water base drilling muds
d = brackish water base drilling muds
e = oil base drilling muds
f = air or gas mist drilling muds

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
A 120	High density inhibitor aid	4	c,d	Dowell
Ace Ben	Sodium polyaerylate	8,15	a,b	Ace Drilling Mud
Ace Flow	Poly acrylamide	8	c,d	Ace Drilling Mud
Ace Seal	Combination fibre flake, granules	10	a,b,c,d e	Ace Drilling Mud
Acestarch	Pregelatin-ized starch	7	c,d	Ace Drilling Mud
Acestarch Preservative	Preservative	2	c,d	Ace Drilling Mud
Ace Tan	Lignosulfon-ate	6,7,14	a,b,c,d	Ace Drilling Mud
Add Foam	Anionic surfactant	9	f	Reef Mud
Air-Foam	Anionic surfactant	9,13	f	Wyo-Ben
Aktaflo-E	Oxyethylated alkyl phenol	6,13	a,b,c,d	Baroid
Aktaflo-S	Mixed oxyethylated phenols	12,13, 14	a,b,c,d, f	Baroid
Aldacide	Paraformal-dehyde	2,4	a,b,c,d	Baroid
Aluminum Stearate	Aluminum stearate powder	5	a,b,c,d	All
Ammonium Bisulfite	Oxygen Scavenger	4	a,b,c,d	Techni-fluids

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Ammonia Sulphate	Ammonia sulphate	12	c,d	Most
Ami-Tec	Oil soluble amine compound	4	a,b,c,d, f	Milchem
Ampli-Foam	Biodegradable cationic surfactant	9	f	Milchem
Ap-21	Non viscosifying polymeric fluid	6,7	a,b,c,d	Techni-fluids
Ap-78	Polymeric viscosifier	15	a,b,c,d	Apex Mud
Ap-Ex	Bentonite extender	8	a	Apex Mud
Aquagel	Sodium type montmorillon-ite	6,7, 11,15	a,b,c,d	Baroid
Aquari	Stabilized HEC & sized carbonates	5,7,10, 15		Brinadd
Aqua-Spot	Weighted spotting fluid	11	a,b,c,d	Milchem
Aqua-Tec	H2O soluble amine	4	f	Milchem
Aspha-Mul	Basic emulsifier	6	e	Wyo-Ben
Atlosol	emulsifier	6,13	a,b,c,d	Milchem
Atlosol-S	Emulsifier	6,13	c,d	Milchem
Attapulgite	Clay viscosifier	15	c,d	Most

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Axmdl	Anionic and nonionic detergent blend	4,11, 13,14	a,b,c,d	Most
Az-32	Nonionic surfactant lubricant	4,11, 13,14	a,b,c,d	Wyo-Ben
Bactericide 400	Cationic quaternary amine	2,4	c,d	Dowell
Barabuf	Magnesium oxide	1,2	a,c,d	Baroid
Baracarb	Ground limestone (CaCO3)	7,10, 16	a,b,c,d, e	Baroid
Baracor A	For solids-free fresh water or brine system	4,12	a,c,d	Baroid
Bara-Defoam I	Surface-active defoamer	5	a,c,d	Baroid
Barafloc	Acrylamide polymeric hydrolife powder	8,12	c,d	Baroid
Barafloc B	Organic polymeric hydrolite powder	8,12	c,d	Baroid
Barite	Processed barites (BaSO4)	16	a,b,c,d, e	Most
Barium carbonate	BaCO3	16	b,d,e	Canamara United
Baroid	Barite, barium sulphate (BaSO4)	16	a,b,c,d, e	Most

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Baroid Asphalt	Oxidized asphalt	7,11,12	a,b,c,d	Baroid
Barapak	Oil soluble packer fluid polymer	15	a,b,c,d	Baroid
Baraplug	Water soluble bridging agent	7	c	Baroid
Bararesin	Oil soluble bridging material	7	a,b,c,d, e	Baroid
Baravis	Pure hydroxyethyl cellulose	15	a,c,d	Baroid
Barazan	High molecular wt polysaccha -ride	6,15	a,b,c,d	Baroid
Barium Carbonate	BaCO3	3	a,b,c,d	All
Barrier	Fluid loss control	7	a,b	Canamara United
Ben Ex	Co-polymer	8,15	a,d	Most
Ben-Ex	Co-polymer, flocculant and clay extender	8,15	a,c,d	Most
Bex	calcium carbonate stabilized HCE	15	a,b,c,d, f	Brinadd
B-Free Heavy Wate	Spotting fluid for stuck pipe with viscosifier	6,11, 13,15	a,b,c,d	Techni-fluids

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Bicarbonate of Soda	NaHCO3	1,3,15	a,b,c,d	All
Bicarbonate of Soda	NaHCO3	1,3	a,b,c,d	ALL
Bit Lube	Lubricant	11	a,b,c,d	Magcobar
Biotrol	Liquid biocide	2	a,b,c,d	Wyo-Ben
Break	Metallic sterrate dispersed in alcohol	5	a,b,c,d, f	Brinadd
Bridge Sal	Polymers, calcium lignosulfon-ate, salt	7	d	Superior Mud Sales
Brigheal	Polymer & sized carbonates	7	a,b,c,d	Brinadd
Brinefoam	Anionic foaming agent	9,13	f	Brinadd
Brine Guard	H2S scavenger zinc carbon-ate	4	a,b,c,d, e,f	Brinadd
Brine-Ox	Solid catalyzed O2 scavenger	4	a,b,c,d	Brinadd
Brine-Pac	For solids-free packer fluid	4	b,c	Milchem
Brine Saver	Oil soluble resin	7,10	a,b,c,d	Dowell
Brine Thicheners	Liquid brine thickener	7,10, 15	c,d	Dowell
Bromo Vis	Polymeric viscosifier for heavy brines	15	c	Baroid

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Broncdefoam	Surface acting defoamer	5	a,b,c,d	Bronco
Broncfluc	Polyacryl-amide	8	a,b,c,d	Bronco
Broncmul	Basic emulsifier	6	a,b,c,d	Bronco
Bronco Gel	Sodium montmorillon-ite	15	a,b,c,d	Bronco
BZC	Basic zinc carbonate	4	b,d,e	Canamara United
Calcium Carbonate	Calcium carbonate	10,16	a,b,c,d, e	All
Calcium Chloride	Calcium chloride	8,12, 16	c,d,e	Most
Calcium Chloride	Calcium chloride	1,8,16	b,d,e	Most
Calcium Lignosulfonate	Calcium lignosulfon-ate	7,14	b,c,d	Wyo-Ben
Can Am Gel	Wyoming bentonite	6,7,15	a,b,c,d	Canamara United
Cane Fibre	Shredded cane	10	a,b,c,d	All
Can Free	Surfactant	13	a,b,c,d, e,f	Canamara United
Carbo-Fast	Relaxed filtrate oil mud	7	e	Milchem
Carbo-Gel	Suspending agent, viscosifier	15	e	Milchem
Carbo-Mul	Emulsifier and oil wetting agent	6	e	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Carbonox	Lignitic humic acid powder	6,7,14	b,c,d	Baroid
Carbo-Sea	Low aromatic oil mud	7	e	Milchem
Carbo-Seal	Modified hydrocarbon	10	e	Magcobar
Carbo-Tec	Control filtrate	7	e	Milchem
Carbo-Tec L	High temperature emulsifier	6	e	Milchem
Carbo-Trol	Filtration control	7	e	Milchem
Carbo-Trol A-9	Non-asphaltic filtration control	7	e	Milchem
Carbwate	Calcium carbonate	16	a,b,c,d, e.f	Brinadd
Caustic Potash	KOH	1,2	a,b,c,d	Most
Caustic Soda	NaOH	1,2,3, 4,15	a,b,c,d	All
Cc-16	Solubilized sodium salt of lignitic humic acid powder	6,7,14	b,c,d	Baroid
Ceascal	Acid soluble sealer LCM	7,10, 12	a,b,c,d	Magcobar
Ceastop	Acid soluble LCM	7,10, 15	a,b,c,d	Magcobar
Cedar Fibre	Shredded cedar	10	a,b,c,d	Most

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Cellex	Sodium carboxymethyl cellulose	7,15	a,b,c,d	Baroid
Cellophane	Cellophane flake	10	a,b,c,d	All
Cel Pak	Anionic cellulose polymer	7,15, 12	a,b,c,d	Imco Services
Chemhib #3	Corrosion inhibitor & anti anerobic bactercide	3,4	a,b,c,d, f	Brinadd
Chemhib-3	Anti-anerobic bactericide & corrosion inhibitor	2,4	a,b,c,d, f	Brinadd
Chem-Trol X	Polymer blend	7,14	a,b,c,d	Milchem
Chrome Lignite	Chrome lignite	6,7,14	b,c,d	Techni-fluids
Cib	Amine compounds and oxygen scavenger	2,4	a,b,c,d	Superior Mud Sales
Circotex	Sized carbonates	7,10, 16	a,b,c,d, e	Superior Mud Sales
Circotex Max	Sized carbonates	7,10, 16	a,b,c,d, e	Superior Mud Sales
C-Lox	Liquid sodium sulphite catalyst	4	a,b,c,d	Canamara United
CMC	Carboxy-methyl-cellulose	7,15	a,b,c,d	All
Coat-44	Sulphide scavenger	4	a,b,c,d	Baroid

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Coat-45	Inorganic zinc salt	4	a,b,c,d	Baroid
Coat-110	Atmospheric corrosion inhibitor	4		Baroid
Coat-129	Oxygen scavenger	4	a,b,c,d, e,f	Baroid
Coat-415	Filming amine	4	a,b,c,d, f	Baroid
Coat-777	Liquid O2 scavenger	4	a,b,c,d	Baroid
Coat-888	Oxygen scavenger	4	a,b,c,d	Baroid
Coat-B1400	Film forming amine salt	4	a,c,d,f	Baroid
Coat-C1815	Filming amine	4	a,b,c,d,f	Baroid
Con Det	Mud detergent	6,12, 13,14	a,b,c,d	Baroid
Corbon 333	Brine inhibitor	4	c,d	Dowell
Core Vis	Polymer blend	15	a,d	Techni-fluids
Corrosion Inhibitor	Zinc chloride and sodium dichromate	4	a,b,c,d, f	Wyo-Ben
Cottonseed Hulls	Cottonseed hulls	10	a,b,c,d, e	Wyo-Ben
Cromex 1	Chrome lignite	7,14, 12	a,b,c,d	Magcobar
Crosfloc CFA-70	Polyacryl-amide	8,12	a,b,c,d	Hart Chemical
Crosfloc CFN-10	Selective flocculant	8	a,c,d	Hart Chemical
Cyanamer 292	Polymer	8,15	a,b,c,	Wyo-Ben

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Cyfloc	Synthetic flocculant	8,13	a,b,c,d	Most
Cypan	Sodium polyacrylate	7	a,b	Most
D-18		16	a,b,c,d, e,f	Dowell
D-31	Barite	16	a,b,c,d, e,f	Dowell
D 47	Organic polymer	5	a,b,c,d	Dowell
D-58	Surfactant	13,14	c,d	Dowell
Dakolite	Lignite	6,14	a,b,c,d	Most
Dakolite	Organic thinner	14	a,b,c,d	Reef Mud
Dap	Diammonium phosphate	3,8,12	a,c,d	Most
D.D.	Drilling mud detergent	6,13	a,b,c,d	Magcobar
Defoam	Aluminum stearate dispensed in diesel	5	a,b,c,d, f	Brinadd
Defoam-2	For polymer systems	5,13	a,b,c,d	Brinadd
Desco	Organic thinner	12,14	b,c,d	Most
Detergent	Detergent	12,13	a,b,c,d	Most
Dextrid	Partially dextrinized polysaccharide	7,8,12	a,b,c,d	Baroid
Df-19	Selective flocculant	8	a,d	Techni-fluids

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Df-20g	Total flocculant	8	a,d	Techni-fluids
Dfm	Polyalcohol ester and sulfonated vegetable oil	5	a,b,c,d	Superior Mud Sales
Df-Vis	Organic viscosifier	15	a,b,c,d, f	Techni-fluids
Diacel D	Diatomaceous earth	10	a,b,c,d, e	Wyo-Ben
Diaseal M	Blended lost circulation additive	10	a,b,c,d, e	Imco Services
Dicks Mud Seal	Shredded organic material	10	a,b,c,d e	Most
Dipel 421	Calcium control polymer	3	a,b,c,d	Canamara United
Dos 3	Diesel oil substitute	6,11	a,b,c,d	Magcobar
Drilfoam	Foaming agent for water	9	f	Baroid
Drill Aid 405	Synthetic oil	11	e	Most
Drill Aid 412	Amine compound	4	a,b,c,d,f	Most
Drill Aid 420	Polymer	8,15	a,b,c,d	Most
Drill Aid 421	Flocculant	8	a,b,c,d	Most
Drill Aid 425	Sodium polyacrylate	7,15	a,b,c,d	Most
Drill Faze	Oil base mud	6,7,15	e	Magcobar
Drilling Detergent	Detergent	6,13	a,b,c,d	Wyo-Ben

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Drilltex	Polymer and sized carbonates	7,15	a,b,c,d	Superior Mud Sales
Drilltreat	Oil mud stabilizer	6,7,13, 14	e	Baroid
Drill X	Torque reducing agent	11	a,b,c,d	Wyo-Ben
Dril-Sol	Polymer blend	8	a,b,c,d	Wyo-Ben
Driscose	Sodium carboxymethyl cellulose	6,7,11, 12,15	a,b,c,d	Most
Drispac	Polyanionic cellulose	6,7,11 12,15	a,b,c,d f	Most
Drispac-Super Low	Polyanionic cellulose	7,15	a,b,c,d	Most
Duovis	XC polymer	15	a,b,c,d	Magcobar
Duratone	Organophilic colloid powder	6,7	e	Baroid
Durenex	Temperature stable lignitic powder	7	a,b,c,d	Baroid
Durogel	High temp. magnesium silicate clay	15	a,b,c,d	Imco Services
Dv 22	Fluid loss control agent	6,7	e	Magcobar
Dv 33	Oil wetting agent	6,7,13	d	Magcobar
Dwa 76	Wetting agent	13	a,b,c,d	Wyo-Ben

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Dx-10	Drilling detergent	6,11, 13	a,b,c	Techni-fluids
Emulgo	Chalk emulsifier	6	a,b,c,d, e	Brinadd
Emulgo Pill	With calcium carbonates	6,10	e	Brinadd
Emulsifier 115	Oil-in water emulsifier	6,13	a,b,c	Techni-fluids
Enkapsulator	Polyacryl-amide	12	c	Canamara United
Ew-20	Emulsifier	6	e	Wyo-Ben
Ez Mud	Liquid polymer viscosifier	15	a,b,d	Baroid
Ez Mul N.T.	Oil soluble surfactant	6,13, 14	e	Baroid
Ex Spot	Oil mud concentrate	11	a,b,c,d, e	Baroid
F 75	Surface active agent	13	a,b,c,d	Dowell
F 78	Surface active agent	9,13	c,d	Dowell
Ferro-Cal	Iron complexed lignosulfon-ate	6,7,14	a,b,c,d	Milchem
Ferrowate	Ferrous carbonate	16	a,b,c,d, e,f	Brinadd
Fibertex	Processed cane fibres	10	a,b,c,d	Baroid
Filtrol	Non-viscosifying fluid loss reducer	6,7	b,c,d,e	Techni-fluids

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Fl-1	Improved organic polymer	12,7	a,b,c,d	Most
Fl 3		7	a,b,c,d, f	Brinadd
Fl 4		7	a,b,c,d,f	Brinadd
Flocculant	Anionic polyacryl-amide	8	a,b,c,d	Wyo-Ben
Flosal	Shredded asbestos	10,15	a,b,c,d	Most
Floxit	Clay flocculant	8	a	Magcobar
Flotex	Lignosul-fonates	7,10	a,b,c,d	Superior Mud Sales
Flr-100	Polymeric fluid loss reducer	6,7,15	a,b,c,d	Techni-fluids
Flr Superlo	Polymeric fluid loss reducer	6,7,14	a,b,c,d	Techni-fluids
Foam Kontrol	Alcohol blend	5	a,b,c,d	Techni-fluids
Galena	Lead sulphide powder	16	a,b,c,d, e	Most
Gel-Air	Anionic foaming agent	9	f	Milchem
Geltone	Oil mud gelling agent	15	e	Baroid
Geogel	Sepiolite clay	7,15	a,b,c,d	Magcobar
Graphite	Graphite	11	a,b,c,d	Most

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Green Band	Treated bentonite	6,15	a,b,c,d	Milchem
Gypsum	Calcium sulphate	7,12	c,d	Most
Hartasist 20	Mixed alcohol	5	a,b,c,d, e	Hart Chemicals
Heaviwater I	Low density clear brine solution	16	c,d	Dowell
Heaviwater II	Low density clear brine solution	16	c,d	Dowell
Heaviwater III	Medium density clear brine solution	16	c,d	Dowell
Heaviwater IV	High density clear brine solution	16	c,d	Dowell
Hematite	Iron carbonate	16	a,b,c,d, e,f	Techni-fluids
Hi Foam	Foaming agent	6,8,11, 13	f	Techni-fluids
High Yield	High yield bentonite	15	a,c	Reef Mud
Hi-Temp	High temperature fluid loss reducer	7,14	a,b,c,d	Techni-fluids
H.M.E.	Nonionic surfactant	6,11, 12,13	a,b,c,d	Most
H-S Polymer	Polyacryl-amide	8,12	c,d	Baroid
HT Kontrol	Temperature stable fluid loss reducer	6,7,14	a,b,c,d	Techni-fluids

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Hydrogel	Wyoming bentonite	15	a,b,c	Wyo-Ben
Hydro-Vis	Polyacrylamide viscosifier	7,8, 12,15	a,b,c	Wyo-Ben
Hytex	Lignosulfonate polymers, carbonates	10	a,b,c,d	Superior Mud Sales
Ima	Salt mud blend	7	c,d	Wyo-Ben
Ima Concentrate	Alcohol and surfactant blend	5,13	b,c,d	Wyo-Ben
Imco Bar	Barite	16	a,b,c,d, e	Imco Services
Imco Bar-Plus	Blended barite & hematite	16	a,b,c,d, e	Imco Services
Imco-Best	Calcium magnesium silicate fibres	15	a,b,c,d	Imco Services
Imco Brinegel	Attapulgite clay	10,15	d	Imco Services
Imco Cide	Liquid carbamate	2	a,b,c,d	Imco Services
Imco Defoam	Sodium alkyl aryl sulfonate	5	d	Imco Services
Imco Ep Lube	Sulfonated tall oil	11	a,b,c,d, e	Imco Services
Imco Flakes	Cellophane flakes	10	a,b,c,d, e	Imco Services
Imco Floc	Polyacrylamide	8	a,b,c,d	Imco Services

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Imco Foamant	Biodegradable surfactant	9	f	Imco Services
Imco Foamban	Surface active defoamer	5	a,b,c,d	Imco Services
Imco Freepipe	Anionic surface active agent	11	a,b,c,d, e	Imco Services
Imco Fyber	Fibre blend	10	a,b,c,d, e	Imco Services
Imco Gel	Sodium montmoril-lonite	7,10, 11,15	a,b,c,d	Imco Services
Imco Gelex	Sodium Polyacrylate	8,15	a	Imco Services
Imco Hole Coat	Asphaltic solids	11,12	a,b,c,d	Imco Services
Imco-Hyb	Extended bentonite	15	a,c,d	Imco Services
Imco Ie Pac	Caustized potassium lignite	1,7,12	a,b,c,d	Imco Services
Imco Ken-Cal	Oil wetting agent	13,14, 16	e	Imco Services
Imco Ken-Gel	Organophilic clay	15	e	Imco Services
Imco-Kenol Conc.	Blended emulsifier & gelling agent	6,7, 15	e	Imco Services
Imco-Klay	Calcium montmori-llonite	7,10 11,15	a,b,c,d	Imco Services
Imco Lig	Processed lignite	6,7,14	b,c,d	Imco Services

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Imco Loid	Pregelatinzed corn starch	7	a,b,c,d	Imco-Services
Imco Lubri Kleen	Blended lubrication materials	11	a,b,c,d	Imco Services
Imco Md	Detergent	6,8,11	a,b,c,d	Imco-Services
Imco Mud Oil	Asphaltic solids in diesel	6,7,11, 12	a,b,c,d	Imco-Services
Imco Myca	Mineral mica	10	a,b,c,d, e	Imco Services
Imco Nu-Dense	Ground hematite	16	a,b,c,d, e	Imco Services
Imco Permaloid	Organic polymer	7,12, 15	a,b,c,d	Imco Services
Imco-Phos	Sodium tetro-phosphate	14	a,b	Imco Services
Imco Plug	Ground walnut shells	10,11	a,b,c,d, e	Imco Services
Imco Polysafe	Multipurpose polymer	7,12, 15	a,b,c,d	Imco Services
Imco Qbt	Quebracho	14	a,b	Imco Services
Imco Rd 2000	Chromefree lignosulfon-ate	6,7, 12,14	a,b,c,d	Imco Services
Imco Rd-III	Blended lignosulfon-ate	3,6,7, 14	b,c,d	Imco Services
Imco Sulf-X 11	Chelated zinc compounds	4	a,b,c,d	Imco Services
Imco Sulf-X 11	Zinc compounds	4	a,b,c,d	Imco Services

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Imco Sumpfloc	Clay flocculant	8	a,b,c,d	Imco Services
Imco Sws.	Anionic surfactant	6,7,11	a,b,c,d	Imco Services
Imco Thin	Causticized lignite	6,7, 14	b,c,d	Imco Services
Imco VC-10	Ferrochrome lignosulfon-ate	3,6,7, 14	b,c,d	Imco Services
Imco Vr	Asphaltic resin	6,7,12	e	Imco Services
Imco-Wate	Calcium carbonate	16	a,b,c,d, e	Imco Services
Imco Wool	Fibrous mineral wool	10	a,b,c,d, e	Imco Services
Imco-XC	Xanthan gum	15	a,b,c,d	Imco Services
Imco X-Corr	Multi-purpose corrosion inhibitor	4	a,b,c,d	Imco Services
Imco X02	Oxygen scavenger	4	a,b,c,d	Imco Services
Impermex	Pregelatin-ized starch	7	a,b,c,d	Baroid
Inde Plug	Hammered styrofoam	10	a,b,c,d	Most
Interlok	All purpose LCM	10	a,b,c,d	Techni-fluids
Invermul N.T.	Oil mud stabilizer non toxic	6,7,15	e	Baroid
IPI-WD	High softening point asphalt	12	b,c,d	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Ironite Sponge	H2S scavenger and oxygen scavenger	4,15, 16	a,b,c,d	All
J 164	Cellulose derivative	7,10, 15	c,d	Dowell
J 274	High density oxygen scavenger	4	c,d	Dowell
Kari	Stabilized HEC	15	a,b,c,d, f	Brinadd
Kelzan Al	Crossed linked XC	6,15	a,b,c,d	Most
Kelzan XC	Carbohydrate biopolymer	6,15	a,b,c,d	Most
K-Flo	Nonionic surfactant	12,13	a,c	Baroid
K-Floc	Liquid flocculant	8	a,c,d	Ken Ham
Kim-Mud	Polymer and sized carbonate	7,10, 15	a,b,c,d, f	Brinadd
Klearfloc	Flocculation aid	8	a,d	Techni-fluids
K-Lig	Potassium lignite derivative	7,12	a,c	Baroid
Kum Free	Surfacant to free pipe	11	a,b,c,d	Canamara United
Kwik-Seal	Combination LCM	10	a,b,c,d	Most
Kwik Thik	Hy-yield bentonite	7,15	a,b,c,d	Magcobar
Kwik Vis	Acresol	7,15	a,b,c,d	Wyo-Ben

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Ld-8	Nonhydro-carbon defoamer	5	a,b,c,d	Milchem
Ligco	Lignite	6,7, 14	a,b,c,d	Milchem
Ligcon	Causticized lignite	6,7, 14	a,b,c,d	Milchem
Lignite	Lignite	6,7,14	b,c,d	All
Lignite, Caustisized	Lignite, caustisized	6,7,14	b,c,d	All
Lime	Ca(OH)2	1,2,4, 8,12, 15	a,b,c,d, e,f	All
Lintex	Fibrous materials	10	a,b,c,d	Baroid
Liqui-Vis	Dispersed liquid HEC	7,15	a,b,c,d	Baroid
Lo-Foam	Rig wash	13	a,b,c,d, e,f	Techni-fluids
Lo Loss	Guar gum	7	a,b,d	Milchem
Lo Wate	Acid soluble weight material	16	a,b,c,d, e	Magcobar
Lube 106	Organic liquid compounds	11,13	a,b,c,d	Imco Services
Lube Kote	Graphite	11	a,b,c,d	Magcobar
Lubetex	Oils and surfactants	11,13	a,b,c,d	Superior Mud Sales
Lubra-Beads	Plastic sphere lubricant	11	a,b,c,d, e	Baroid
Lubri-Film	Lubricant	4,11	a,b,c,d	Milchem
Lubri-Sal	Nonpolluting lubricant	11	a,b,c,d	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Lubriglide	Thermo-plastic polymer	11	a,b,c,d, e,f	Techni-fluids
4M+4	Hydrolized polyacryl amid	12,15	a,b,c,d	Magcobar
M129.1	Oxygen scavenger	4	a,b,c,d	Dowell
Magcobar	Barium sulphate	16	a,b,c,d, e	Magcobar
Magco Cfl	Chrome lignosulfon-ate	7,14	a,b,c,d	Magcobar
Magco Foamcheck	Defoamer	5	a,b,c,d	Magcobar
Magcogel	Wyoming bentonite	7,15	a,b,c,d	Magcobar
Magco Inhibitor 101	Amine type inhibitor	4	a,b,c,d	Magcobar
Magco Inhibitor 202	Amine inhibitor	4	a,b,c,d,f	Magcobar
Magco Inhibitor 303	Amine type inhibitor	4	a,b,c,d	Magcobar
Magcolube	Biodegradable lubricant	11	a,b,c,d	Magcobar
Magconate	Petroleum sulfonate emulsifier	6	a,b,c,d	Magcobar
Magconol	Octyl alcohol	5	a,b,c,d	Magcobar
Magcophos	Sodium tetraphosph-ate	3,14	a,b,c,d	Magcobar
Magco Polypac	Polyanionic cellulose	6,7,11, 12,15	a,b,c,d, f	Magcobar

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Magco Polypac-Ultralo	Polyanionic cellulose	6,7,11, 12,15	a,b,c,d, f	Magcobar
Magco Poly Sal	Modified poly-saccharide	7,15	a,b,c,d	Magcobar
Mc-500	Fluid loss control	7	e	Wyo-Ben
Mc Defoamer	Liquid general purpose	5	a,b,c,d	Milchem
Md-30	Multi-functional	13	a,b,c,d, f	Wyo-Ben
Mf-1	Selective flocculant	8	a,c,d	Most
Mica	Sized mica flake	10	a,b,c,d, e	Most
Micatex	Mica flakes	10	a,b,c,d, e	Baroid
Mil-Bar	Barite	16	a,b,c,d, e	Milchem
Milbio	Biodegrade-able biocide	2	a,b,c,d	Milchem
Mil-Cedar Plug	Shredded, cedar fibres	10	a,b,c,d	Milchem
Milchem Cmc	Sodium carboxyl methyl cellulose	6,7,15	a,b,c,d	Milchem
Milchem Md	Detergent	13	a,b,c,d	Milchem
Mil-Clean	Biodegradable detergent	13	a,b,c,d	Milchem
Mil-Con	Neutralized heavy metal modified lignite	7,14	a,b,c,d	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Mil-Emulsifier	Biodegradable detergent	13	a,b,c,d	Milchem
Milex	Co-polymer	8,15	a,d	Milchem
Mil-Flo	Polyflavinoid compound	6,7,14	a,b,c,d	Milchem
Mil-Free	Diesel oil spotting fluid	11,13	a,b,c,d	Milchem
Mil-Fiber	Processed cane fibres	10	a,b,c,d	Milchem
Milflake	Shredded cellophane flakes	10	a,b,c,d	Milchem
Mil-Gard	Zinc catbonate	4	a,b,c,d,e	Milchem
Milgard R	Chelated zinc ligno-sulfonate	4	b,c,d	Milchem
Milgel	Sodium type montmorillon-ite	7,15	a,b,c,d, f	Milchem
Milmica	Nonabrasive mica flakes	10	a,b,c,d, e	Milchem
Mil-Plug	Ground walnut hulls	10	a,b,c,d, e	Milchem
Mil-Polymer 302	Biodegradable polymeric viscosifier	15	a,c,d	Milchem
Mil-Polymer 303	Polymer with biocide	15	a,c,d	Milchem
Mil-Polymer 304	Polymer with biocide	15	a,c,d	Milchem
Mil-Polymer 305	Polysacchar-ide	15	a,c,d	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Mil-Polymer 306	High calcium and salt tolerant polymer	15	a,b,c,d	Milchem
Mil-Quebracho	Pure quebracho extract	6,14	a,b	Milchem
Mil-SOS	Hydrolized polyacryl-amide	8,12	a,c,d	Milchem
Mil-Spot	Oil based spotting fluid	11	a,b,c,d	Milchem
Milstarch	Pregelatined starch	7	a,b,d	Milchem
Mil-Temp	Polymeric deflocculant	14	a,b,c,d	Milchem
Mon Cose	Sodium carboxy-methyl cellulose	6,7,11, 12	a,b	Most
Mon Ex	Bentonite extender	8,15	a	Most
Mon-Pac	Polyanionic cellulose	7,15	a,b,c,d	Wyo-Ben
Mud-Pac	Corrosion inhibitor	4	a,b,c,d	Milchem
Mylo Gel	Pregelatin-ized starch	7	a,b,c,d	Magcobar
Mylo-Gel Preservative	Starch preservative	2	a,b,c,d	Magcobar
Naturalgel	Untreated bentonite	7,11, 15	a,b,c,d	Wyo-Ben
No-Stik	Blend surface agents	11,13	a,b,c,d	Most

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Noxygen	Sodium sulphite	4	a,b,c,d	Milchem
Noxygen L	Ammonium bisulfate	4	a,b,c,d	Milchem
Nsm	Polymeric viscosifier	7,15	a,b,d	Techni-fluids
Nut Plug	Ground Walnut Hull	10		Magcobar
Nymcel	Carboxymeta-cellulose	7,15	a,b,c,d	Most
Oil Faze	Oil base mud	6,7,15	e	Magcobar
Oilfos	Sodium tetra-pyrophosphate	3,14	b,d	Milchem
Oil "N" Water	Emulsifier	6,13	a,b,c	Canamara United
Oilsperse	Organic emulsifier	6,13	e	Brinadd
Omc	Degellant	14	e	Baroid
Omg-40	Organophilic clay	6,15	e	Wyo-Ben
007	Caustisized lignite	6,7,14	a,b,c,d	Ace Drilling Mud
OS-I	Catalyzed sodium sulphite	4	a,b,c,d	Magcobar
OSI-1	Ammonium bisulfite	4	a,b,c,d	Magcobar
OSS PILL	Oil soluble resin	10	a,b,c,d,	Brinadd
Ostex	70% ammonium bisulfite	4	a,b,c,d	Superior Mud Sales

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Pactex	Polymers and complexing compounds	15	a,b,c,d	Superior Mud Sales
Paper-Ox	Shredded paper	10	a,b,c,d	Milchem
Paraformal-dehyde	Starch preservative	2	a,b,c,d	All
Peltex	Lignosulfon-ate	6,7,14	a,b,c,d	Most
Peltex	Ferrochrome lignosulfon-ate	6,7,14	a,b,c,d	Most
Perma-Film	Film forming corrosion inhibitor	4	a,b,c,d	Imco Services
Perma-Lose HT	Hydrophilic organic polymer	7	a,b,c,d	Milchem
Petro Seal	Paper products	10	a,b,c,d, e	Ace Drilling Mud
Petrotone	Organophilic clay suspending agent	15	e	Baroid
Ph-10	Magnesium oxide	1	a,b,c,d e,f	Brinadd
Phosphate	(NaPO3)6	4	a,b,c,d	Wyo-ben
Pipe-Guard	Inhibitor for oxygen corrosion	4	a,b,c,d	Milchem
Pipe-Lax	Surfactant mixed with diesel	13	a,b,c,d, e	Magcobar
Plaster	Calcium sulphate	8,12, 15	c,d	All

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Plaster of Paris	CaSO4.1/2H2O	7,13	c,d	All
Plug-Git	Hardwood fibre	10	a,b,c,d	Baroid
Polidril	Polymer blend	15	a,b,c,d, f	Brinadd
Poliheal	Polymer blend	7	a,b,c,d	Brinadd
Polybrind	Calcium carbonate	7,15	d	Magcobar
Poly-Bridge	Polymer	10	a,b,c,d	Milchem
Polyguard	Shale inhibitor	12	a,b,c,d	Canamara United
Polymix	Polymer blend	15	d	Magcobar
Poly Mul	Oil-in-water emulsifier	6,13	a,b,c	Techni-fluids
Poly Plastic	Shale stabilizer	7,12	a,b,c,d	Techni-fluids
Poly Rx	High temperature polymer	7,12	a,b,c,d	Imco Services
Poly S	Satium polyacrylate blend	7,15	a,b,c,d	Wyo-ben
Poly S	Shale stabilizer	7,12	a,b,c,d	Canamara United
Poly Seal	Polyethene flank	10	a,b,c,d	Most
Poly Sec	Flocculant extender	8,15	a,b,c,d	Canamara United
Poly Sec K D	Bentonite extender	8,15	a,b	Canamara United

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Polytex	Polymers, sized carbonates	7	a,b,c,d	Superior mud sales
Potash	Potassium chloride	8,12, 16	a,c,d	Most
Permium Gel	Wyoming bentonite	15	a,b,c,d	Canamara United
Pre-mix	Unpeptized API bentonite	7,11, 15	a,b,c,d	Techni-fluids
Pretex	Surface active agents	13	a,b,c,d	Superior Mud Sales
Pro-3	Inhibitor	4		Milchem
Pro-Ex	Flocculated extender	8,15	a,c,d	Protec mud
Pro Fiber	Shredded materials	10	a,b,c,d, e	Wyo-Ben
Pro-Film	Film forming amin	4	a,b,c,d, f	Protec Mud
Pro-Floc	Polyacrylam-ide	8,12	a,b,c,d	Protec mud
Pro-Scale	Phosphonate scale inhibitor	13,4	a,b,c,d	Protec Mud
Pro-Scav	Sodium sulphite powder	12,4	a,b,c,d	Protec Mud
Pro-Scav A	Ammonium bisulphite	4	a,b,c,d	Protec Mud
Pro-Scav S	Sodium bisulphite	4	a,b,c,d	Protec Mud
Protectozone	Thickeners	7,10, 15	c,d	Dowell

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Qb II	Chrome lignosulfonate	6,7,14	a,b,c,d	Baroid
Q-Broxin	Ferrochrome lignosulfonate	6,7,14	a,b,c,d	Baroid
Quebracho	Quebracho tannin extract	7,14	a,b,c,d	Most
Quick Lime	Calcium oxide	1,2,4, 12	d,e,f	Wyo-ben
Quik-Foam	Foaming agent	9	f	Baroid
Quik-Gel	High yield bentonite	7,15	a,b	Baroid
Quik-Mud	Viscosifiers	7,15	a,f	Baroid
Quik-Trol	Organic polymer	12,15	a,b,c,d	Baroid
R-2264	Filming amine	4	a,b,c,d, f	Reef Mud
Rapid Foam	Foaming agent	9	f	Magcobar
Rapidril	Organic polymer	8,15	a,d	Magcobar
Rayuan	Chrome lignosulfonate	14	a,b,c,d	Most
Rayvan	Chrome lignosulfonate	6,14	a,b,c,d	Most
Reef O2	Catalyzed sodium sulphite	4	a,b,c,d, f	Reef Mud
Reef Carb	Calcium carbonate	7,10, 16	c	Reef Mud
Reef Defoam	Alcohol compounds	5	a,b,c,d	Reef Mud

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Resinex	Synthetic resin	7,12	a,b,c,d	Magcobar
Rm-66	Polymer	12,15	a,b,c,d	All
Ruf-Plup	Corn cob	10	a,b,c,d, e	Wyo-Ben
Safeguard 5000	Amine base corrosion inhibitor	4,6	a,b,c,d	Techni-fluids
Safeguard 5500	Oxygen scavenger	4	a,b,c,d	Techni-fluids
Salex	Sodium polyacrylate blend	7	c,d	Wyo-ben
Salinex	Chemical emulsifier	6	d	Magcobar
Salt	NaCl	3,8,12 16	c,d,e	All
Salt Gel	Attapulgite clay	15	a,b,c,d	Magcobar
Salt Inhibitor	Amino acid amides	4	c,d	Reef Mud
Salt Mud	Attapulgite clay	15	c,d	Ace Drilling Mud
Salt water Gel	Attapulgite	15	a,b,d	Milchem
Sanheal Pill	Calcium carbonate	10	a,b,c,d	Brinadd
Sapp	Sodium acid pyrophosphate	1,3,14	a,b,c,d	All
Sawdust	Sawdust	10	a,b,c,d	All
Scale-Ban	Scale inhibitor	4	a,b,c,d	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Scavox	Ammonium bisulphite	4	a,b,c,d	Canamara United
Sea Mud	Processed sepiolite	15	c,d	Wyo-ben
Selec-Floc	Selective flocculant	8	a	Apex Mud
Separan	Clay flocculant	8	a,b,c	Most
Sepiolite	Thermally stable clay	15	a,b,c,d	Techni-fluids
Sf-100	Mixed oleophilic powder	6,7, 13,15	a,b,c,d, e	Baroid
Shale Kontrol	Shale stabilizer	12	a,b,c,d	Techni-fluids
Shale-Gard	Water dispersible asphalt	7,12	a,b,c,d	Milchem
Shale-Trol	Organo-aluminum complex	12	a,b,c	Milchem
Shershale	Asphaltic shale inhibitor	12	a,b,c,d	Canamara United
Sherspot	Spotting compound	11	a,b,c,d	Canamara United
Shertone	Organophilic clay	15	e	Canamara United
Sherwellx10	Polymeric bentonite extender	8	a	Canamara United
Si-1000	Organic phosphate scale inhibitor	4	a,b,c,d	Magcobar

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Sigtex	Polymers	15	a,b,c,d	Superior Mud sales
Simple Seal	Carlcium carbonate	10	a,b,c,d	Brinadd
Skot Free	Surfactant mixed with diesel	13	a,b,c,d	Baroid
Sluggits	Calcium carbonates	10		Brinadd
Slugheal	Calcium carbonate	7	c,d	Brinadd
S.M.R.	Polymeric viscosifier	15	a,d	Techni-fluids
Soda Ash	Sodium carbonate	1,3	a,b,c,d	All
Sodium Bichromate	Sodium dichromate dihydrate	4,14	a,b,c,d	Wyo-Ben
Sodium Chromate	Na2CrO44H2O	4	a,b,c,d	Most
Sodium Hexameta Phosphate	(NaPO3)6	4	a,b,c,d	Wyo-Ben
Sodium Sulphite	Oxygen scavenger	4	a,b,c,d	Most
Soltex	Sodium asphalt sulphonate	6,11,12	a,b,c,d	Most
Soltex	Sodium asphalt sulphonate	6,11,12	a,b,c,d,f	Most
Salubriges	Oil soluble resins	10	a,b,c,d, f	Brinadd
Soluvis	Polymer & sized resins	7,10,12, 15		Brinadd

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Solukleen	Oil-soluble resin based	7	c,d	Brinadd
Solvaguik Pill	Chalk	10	f	Brinadd
Sp-100	Acrylonitrile polymer	7,14	a,b,c,d	Imco Services
Spacer 1000	Mud remover	14	c,d	Dowell
Spacer 3000	Mud remover	14	c,d	Dowell
Spersene	Chrome lignosulfon-ate	7,14	a,b,c,d	Magcobar
Spot	Oil base spotting fluid	11	a,b,c,d	Imco Services
Ss-100	Shale encapsulator	12	c,d	Techni-fluids
Sst 200	Aluminum salt	12	b,d	Milchem
Stabilhole	Blown asphalt	6,7,12	a,b,c,d	Magcobar
Staflo	Polyanionic cellulose powder	6,7,12 15	a,b,c,d,f	Most
Staflo	Polymer	7,15	a,b,c,d	Most
Starch	Starch	2,4,7	a,b,c,d	All
Starlose	Nonfermenting organic polymer	7	a,b,c,d	Milchem
Sulphate of Potash	K2SO4	12	a,b,c,d	Most
Super-Col	Modified high-yield bentonite	15	a,b,d	Milchem
Super Floc	Organic polymer	8	a,b,c,d	Most
Super Gel	High yield clay	8,11,15	a,b,c,d	Canamara United

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Super-Gel	Modified extra high yield Wyoming bentonite	7,15	a,b	Canamara United
Super Gel X	High yield clay	11,15	a,b,c,d	Canamara United
Super Lig	Lignite	6,7,14	b,c,d	Canamara United
Super-Lube-Flow	Gilsonite	11,12	a,b,c,d	Most
Super Visbestos	Pelletized asbestos suspending agent	15	a,b,c,d, e	Most
Super Wate	High density weight material control	16		Magcobar
Surfak E	Nonionic emulsifier	6	a	Magcobar
Surf-Cote	Oil wetting agent	6,13	e	Milchem
Surflo-H35	Anionic phosphonate liquid scale inhibitor	4,13	a,b,c,d	Baroid
Surflo-S30	Anionic biodegradable foaming agent	9,13	a,b,c,d	Bariod
Surflo W200	Surface-active defoamer	5	a,b,c,d	Baroid
Surflo W300	Surface-active defoamer	5	a,b,c,d	Baroid

PRODUCT NAME	PRODUCT DESCRIPTION	FUNCTIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Tann A.Thin	Lignite	7,14	a,b,c,d	Magcobar
Targuard	Core protective	12	a,b	Techni-fluids
Techni-Cal	Sized CaCO3	16	a,b,c,d	Techni-fluids
Technihib	Polyphosph-ate scale inhibitor	4	a,b,c,d	Techni-fluids
Technisperse	Lignosulfon-ate dispersant	6,7,14	a,b,c,d	Techni-fluids
TF EX	High yield bentonite extender	15	a,b,c,d	Techni-fluids
Thikquik	Stabilized HEC	7,12,15	a,b,c,d, f	Brinadd
Thix	Blended polymers	15	a,b,c,d, e,f	Brinadd
Thix-Pak	Stabilized thixotropic polymer	15	a,b,c,d, e,f	Brinadd
Tor Kontrol	Biodegradable torque reducer	11	a,b,c,d	Techni-fluids
Toro-trim	Biodegradable blend of triglycerides and alcohols	11	a,b,c,d	Baroid
Torque-less Dii-170	Friction reducing glass beads	11	a,b,c,d	Milchem
Trimulso	Oil-in-water emulsifier	4,6,11 13	a,b,c,d	Baroid
Ts301	Lignosulfon-ate complex	7,14	a,b,c,d,f	Brinadd
T-Z Pill	Reactive polymer	10	a,b,c,d	Brinadd

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
U 66	Universal solvent	13,14	c,d	Dowell
U.l.S.S.	Oil-in water emulsifier	6	a,b,c,d,e	Baroid
Uni-Cal	Chrome lignosulfonate	6,7,14	a,b,c,d	Milchem
Unical S.E.A.	Chrome free lignosulfonate	6,7,14	a,b,c,d	Milchem
Uni-Drill	Blend sodium polyacrylates	7,15	a,b,c,d	Wyo-ben
Uni-Steam	Corrosion inhibitor	4	c,f	Magcobar
Vertoil	Invert base	6,12,15	e	Magcobar
VG-69	Gelling agent	15	e	Magcobar
Visbestos	Shredded asbestos suspending agent	15	a,b,c,d, e	Most
Visquik	Inorganic viscosifier	15	a,b,c,d	Magcobar
Vistex	Polymers and carbonate	15	a,b,c,d	Superior Mud Sales
Walnut Hulls	Ground Walnut Shells	10	a,b,c,d e	All
Weightex	Sized CACO3	16	a,b,c,d	Superior Muds Sales
Weight Sal	Sized salt	16		Superior Mud Sales
Wl 100	Sodium polyacrylate	7	a,d	Most
W.O. 20	Hydroxylethyl cellulose with calcium carbonates	15	a,b,c,d	Milchem

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
W.O. 21	Hydroxylethyl cellulose	15	a,b,c,d	Milchem
W.O. 22	Acid soluble polymeric viscosifier	15	a,b,c,d	Milchem
W.O. 23	Acid soluble polymeric viscosifier	15	a,b,c,d	Milchem
W.O. 30	Calcium carbonate	7,10, 16	a,b,c,d, e	Milchem
W.O. 35	Ferrous carbonate	16	a,b,c,d f	Milchem
W.O. 50	Polymer & graded calcium carbonate		a,d	Milchem
W.O. Defoam	Alcohol base defoamer	5	a,b,c,d	Milchem
Wonderseal	Blend of hydrocarbon resins	11,12	a,b,c,d	Magcobar
Workover One	Acid soluble viscosifier	7,10,15	a,b,c,d	Baroid
Wyo-Foamer	Aqueous emulsion defoamer	5,11,13	a,b,c,d	Wyo-ben
Wyo-Foamer	Foaming agent	6,9,11, 13	f	Wyo-ben
Wyo-Gilsol	Bitumen dispersant	5,6,11, 12,13	a,b,c,d	Wyo-ben
Wyoming 85	Untreated bentonite	7,6, 11,15	a,b,c,d	Canamara United
Wyoming Gel	Sodium montmorillon-ite	6,7, 11,15	a,b,c,d	Canamara United

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Wyo-Surf	Surfactant	4,6,11, 12,13 14	a,b,c,d	Wyo-ben
XC Polymer	High molecular weight xanthum gum polymer	6,15	a,b,c,d	Most
Xl Defoamer	Alcohol defoamer	5	a,b,c,d	Canamara United
Xkb-Thin	Deflocculant	14		Milchem
Xp-20	Chrome lignite	7,14	a,b,c,d	Magcobar
X-Pel	Air blown asphalt	12,13	f	Most
X-Pel-G	Treated gilsonite	7,11,12	a,b,c,d	Most
Ypc 71	Polyacrylam-ide	15	a,b,d	Mudco Services
Zac 12	Zn tetra-ammonium carbonate	4	b,d,e	Canamara United
Zeogel	Attapulgite powder	10,15	c,d	Baroid
Zeq	Polymer blend	15	a,b,c,d	Brinadd
Zinc Carbonate	H2S scavenger	4	a,b,c,d	All
Zinc Knockout	H2S scavenger	4	a,b,c,d	Canamara United
Zinc-O-Lite	Liquid H2S scavenger	4	b,d,e	Canamara United
Zinc-O-Mate	H2S scavenger	4	a,b,c,d	Canamara United

PRODUCT NAME	PRODUCT DESCRIPTION	FUNC-TIONS	SYSTEMS USED IN	DISTRIBUTOR IN CANADA
Zinc-O-Sponge	Hi surface area ZnCO3	4	b,d,e	Canamara United
Zinc-O-Zorb	H2S scavenger	4	a,b,c,d	Canamara United
Zonelock	Water Shut-off or plugging	10,16	a,b,c	Dowell